Plant Breeding and the Cotton Industry

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TO UNDERSTAND the contribution that breeding has made to the cotton industry it is necessary first to know something about the origin of the various existing types of cotton. Scientists engaged in this field seem agreed that there were probably two general centers of origin of the cotton plant, one in the Old World and one in the New World. It is the opinion of some investigators that there might have been two centers of origin in the Old World, Indochina and tropical Africa, and that in the New World cotton might have either originated independently in two regions—Mexico or Central America, and the foothills of the Andes Mountains of South America—or have developed along different lines in these two regions. The cultivated cottons of today seem to trace back to cottons grown in ancient times in one or another of these four world centers. Archeological specimens indicate very ancient usage of cotton in Mexico and in South America and indigenous species in the Old World furnish some evidence of the double origin in that hemisphere.

Recent studies on the relationship of cottons from different parts of the world indicate that the American and Asiatic cottons have remained distinct probably since their origin. They are still so incompatible that crossing between them is rare, and persisting fertile hybrids are unknown. The American cottons have 26 chromosomes and the Asiatic species only 13. There are many different types and a number of different species of both Old World and New World cottons, however, and all of the cultivated forms of New World origin seem to cross readily with each other, although those that originated in South America are genetically quite different in many respects from those more recently introduced from Mexico. While the three types of cotton now grown in this country—sea island, American-Egyptian, and upland—are all probably of American origin, it would seem that the sea island and the American-Egyptian originally came from South America, and that all of the upland varieties either came originally from Mexico or at some time in the past arose from crosses of Mexican and South American species. Hybridization of North and South American species especially may account for some of the upland long staple varieties.

The Kinds of Cotton, the Background of the Breeder's Work, and the Relation of Breeding to Present Economic Needs

COTTON breeders also seem agreed that practically all of the varieties grown today are of hybrid origin; that is, they are hybrids of the older varieties of the same species or of the more compatible species. Many of these hybrids probably arose from natural crosses in fields where several varieties were grown together or near each other. Occasionally interspecific crossing may have occurred in situations where more than one species was cultivated in close proximity. The history of the origin and development of these cottons is very meager. Probably the type with the most definitely known historical background is the sea island, introduced into this country in Georgia from the Bahama islands about 1785. The sea island cotton also offers a good illustration of what careful selection and breeding will do. While information as to the methods pursued by the early growers is fragmentary, the results they secured are quite evident.

In connection with the development of the sea island cotton industry it is possible that more than one species and no doubt several varieties were brought in during the early period at the end of the eighteenth century and the beginning of the nineteenth. From these introductions, the sea-island growers doubtless developed their own distinct varieties and strains, but no descriptive records were kept. These early breeders knew little of genetics or the science of plant breeding, but they were artists in knowing their plants. They sought practical ends and concentrated on the development of the long silky type of cotton that the English spinners of that time demanded. Their ideas were based on philosophical biology rather than on scientific biology, taxonomy, or genetics. They felt that environment had considerable effect in producing changes in plants but that heredity transcended all external influences, and that like did really beget like. With this philosophy as a guide, and expertness in observing, sorting, and selecting, they were equipped to build up a great enterprise through plant breeding. Among these growers a particular variety was considered the personal property of the originator and seed was not exchanged or sold unless something better was at hand. The result was the development of many special strains of the finest cotton the world has ever known. Sea island cotton production (fig. 1) was limited to the islands off the coast of South Carolina and Georgia and to a narrow strip of mainland near the coast. The cottons grown in the interior, on the mainland, were of an entirely different type and were designated as upland cottons.

As early as the seventeenth century there are records of the bringing in of cottons from many parts of the world for growing in the interior. These were grown entirely for domestic use, and apparently little attention was paid to the quality of the fiber or the productiveness of the plants. It was not until cotton mills began to develop

and industrial uses were found for cotton that the growers of upland cotton began to pay attention to yield and to some extent quality. Since the Old World and New World cottons are not known to hybridize under conditions of cultivation and all of the upland varieties now grown in this country are quite definitely of the American type, it seems evident that among all the cottons brought together from various parts of the world at different times, the ones that survived in the upland growing area have been entirely of American origin and probably all came from Mexico and Central America. The vast differences in climate and soil that obtain over the Cotton Belt undoubtedly brought about a kind of natural selection which eliminated many of the kinds that were tried, while others became adapted to the several conditions under which they were grown and selected over a period of years.

BEGINNING OF COMMERCIAL PRODUCTION, AND THE EFFECT OF THE BOLL WEEVIL

As a result of such adaptation and selective breeding, there were many different types of upland in existence when cotton first became important as a commercial crop after the middle of the eighteenth century. These represented different sections of the Cotton Belt. In the eastern end the smaller bolled, prolific cottons were predominant. These were characterized by green seed and softer fiber than was found later in the stock farther west, where the cottons had large bolls, coarse fiber, and white seed. It is possible that the eastern Cotton Belt group came originally from the more humid eastern portions of Central America and Mexico while the more recent western Cotton Belt group was introduced from the interior and drier sections of Mexico. The older or pre-boll-weevil upland long staple type belonged to the former group and apparently had the same origin, with the exception of possible hybridization in some cases with sea island.

However, before the present western end of the Cotton Belt was developed, cottons from the interior or drier sections of Mexico began to come into the eastern growing areas of the United States. These types, which were characterized by large white seed, large bolls, and hard fiber, later became predominant in the western end of the Cotton Belt and in much of the East. About the first recorded importation of this type was one made by Walter Burling, who brought cotton from Mexico City to Natchez, Miss., in 1806. This variety was introduced in South Carolina about 1816 and eventually became the parent of a large number of varieties in that part of the Cotton Belt. It is thought that soldiers returning from the Mexican War of 1846 to 1848 also brought back seeds of this type, which doubtless became foundation stock of the big-boll stormproof cotton of Texas and some other parts of the western area.

In the 1850's a large-boll white-seeded cotton was introduced into Georgia by a German immigrant whose brother sent the seed to him from Algeria. This cotton was of the Mexican big-boll sort and perhaps was of Mexican origin. The importation later became the foundation stock for Jones Improved, Truitt, Russell, Columbia, Keenan, Hartsville, Webber, and much of the later breeding lines of the Coker's Pedigreed Seed Co. Greenish or green seed, particularly in Truitt and Russell, doubtless came about through cross-pollination.

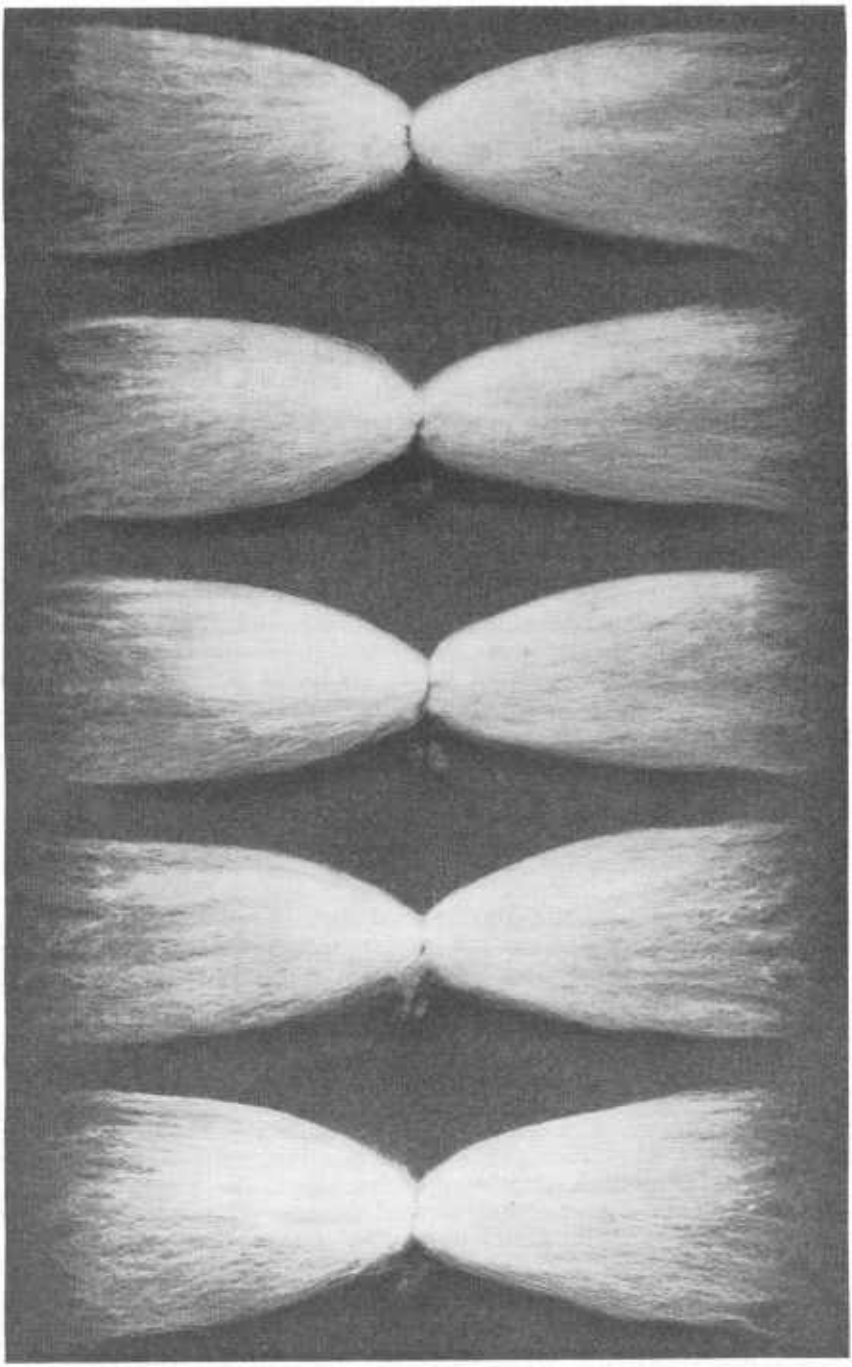

FIGURE 1.—Combed fibers on individual seeds of sea island cotton to show length of fiber and seed characteristics. Natural size.

During the first part of the present century, important stocks again were brought in from Mexico and Guatemala. Of these importations, Durango and Acala, the latter particularly have been notable introductions. These varieties respectively from western and southern Mexico and dry regions resemble the kinds previously brought in from the semiarid table land of that country. The kinds introduced from the humid eastern area of Guatemala—Kekchi, for example—had white seed and big bolls but were more like the old eastern Cotton Belt group of varieties in plant type and fiber texture. The Mexican sorts that have come from time to time directly across the Rio Grande have completely occupied the cotton area of the Southwest, Texas, Oklahoma, and much of Arkansas and Louisiana, and have invaded large portions of the eastern end of the belt. They have also been hybridized with the eastern varieties to such an extent that green-seeded varieties have practically disappeared. However, the small non-storm-resistant bolls and softer staple have prevailed as characteristics in many of the eastern varieties, probably because of selection under humid conditions. The large-boll hard-staple type seems to thrive better under dry conditions.

The spread of the boll weevil over the Cotton Belt at the beginning of the present century caused a widespread change in the types of cotton grown in the different regions. In the central part of the belt many large, vigorous-growing types of upland long-staple cotton had come to be grown very generally, and in much of the mid-South and Southeast the later maturing varieties of the shorter staple type had proved more productive and were of better staple than the recent short staple type. When the boll weevil struck these areas, however, it was no longer possible to grow late-maturing varieties. Varieties that had long been famous for high quality but were late in maturing were discarded and early short-staple cottons were substituted. These were usually inferior in quality but had developed early maturity and the determinate habit of growth—that is, they fruited rapidly instead of over a long season—from having been grown and selected on the northern rim of the Cotton Belt. There were only two criteria for these varieties—they must be early and productive.

In this way many excellent varieties of long-staple upland cotton and practically all of the better types of medium-staple were lost within a comparatively short time, to be replaced by the early, rapid-fruiting types brought in from the northern parts of the belt, wherever they were found. In the regions first occupied by the boll weevil some progress had already been made in developing early strains of the Texas Big Boll cottons, and by reselection these became adapted to a wide area west of the Mississippi River. In the eastern part of the belt breeders began breeding for earliness and rapid fruiting even before the boll weevil reached these sections. Trice in Tennessee, some of the Cleveland and Webber strains in South Carolina, Mexican and Cleveland strains in North Carolina, and Cook in Alabama, served in part to meet the situation when the boll weevil finally infested the Southeast.

RESULTS OF BREEDING FOR IMPROVED STAPLE

Considerable impetus was given to cotton breeding about this time, largely through the discovery that many of the early maturing cottons were of very inferior quality and that their production was

resulting in the loss of special markets which had been using the better cottons of pre-boll-weevil days for many years. The Department of Agriculture, several of the experiment stations, and such outstanding breeders as the Coker's Pedigreed Seed Co. and W. W. Wannamaker, of South Carolina, the Delta & Pine Land Co., of Mississippi, C. N. Nunn, of Oklahoma, John Gorham, A. M. Ferguson, Ed. Kasch, and R. L. Bennett, of Texas, and others began to develop rapid-fruiting early maturing varieties with better and more uniform staple. The foundation stock for these strains came quite largely from the western cottons, although in some cases the most outstanding developments resulted from hybridization between the eastern and western groups. Certain strains of Delfos, Missdel, Express, Wilds, Stoneville, Delta & Pine Land, Cleveland, Farm Relief, Acala, Rowden, Lone Star, Mebane Triumph, Mexican, etc., have developed to the point where seed is now available in all parts of the belt, and some of these are being used as foundation stock in one-variety communities for standardizing production of the American crop on a one-variety-community basis.

Another outstanding accomplishment of the cotton breeder in developing cottons of superior quality to meet a special situation resulted from the widespread occurrence of cotton wilt, first in the Southeast and later over the Coastal Plain section of the entire Cotton Belt. Wilt had been encountered on the sea islands in the early days and some of the breeders on the islands had developed resistant strains that were almost immune to the disease. Taking a lead from this work of the sea-island breeders, Orton and later Gilbert, Watson, McLendon, Lewis, and Tisdale, breeding cotton in different sections of the Southeast, developed strains highly resistant to the wilt fungus. Before these varieties became available there were large areas in the Southeast that could not safely be planted to cotton. Since their development, cotton can be grown without danger from the wilt hazard in every section of the South.

There is very definite statistical evidence of the improvement in the staple length of the American cotton crop as a result of the breeding work done during the past decade. The grade and staple statistics section of the Division of Cotton Marketing of the Bureau of Agricultural Economics made the first report of the grade and staple length of the cotton crop in 1928. In 1929, 58 percent of the crop was seven-eighths of an inch or less in length. There has been a rather consistent improvement in the staple length of the cotton crop since that time. In 1935, only 44 percent of the crop was as short as seven-eighths of an inch. The greatest improvement has taken place in the medium staples, $^{15}/_{16}$ to $1^{1}/_{16}$ inches, inclusive. In 1928, only 39 percent was of these lengths, whereas in 1935, this had increased to 50 percent of the crop. On the whole there has been an increase in the average staple length of the entire crop of approximately one-thirty-second of an inch. Interpreted in terms of premiums and discounts for staple prevailing in 1935, this has resulted in an increased value for the 1935 crop of about 80 cents a bale, a total of approximately $8,000,000. This improvement is due largely to the development by our leading breeders of more productive strains of cotton of better staple length and general quality and to the wider use of these better strains on a more standardized basis either by organized communities or by following Extension Service recommendations throughout the Cotton Belt.

FOREIGN COMPETITION CREATES A PRESSING NEED FOR MORE RAPID PROGRESS

While these definite accomplishments are comforting, conditions have arisen during the past 5 or 6 years which make it necessary to go forward in breeding and improvement work more rapidly than in the past. While the United States was improving the staple length and quality of its cotton, other countries were doing the same thing, many of them by importing seed of the best North American varieties and adapting these varieties to their own conditions. As some of the larger consuming countries, following a policy of national self-sufficiency, have attempted to produce the cotton they need or to purchase it from other countries with which they have a favorable trade balance, there has been a falling off in the demand for American cotton. It would seem that if these markets are to be regained, it will be necessary for the United States to produce better cotton than is grown anywhere else in the world. It seems necessary, therefore, not only to continue to improve the staple length and uniformity of American cotton but to breed into the new strains other quality factors that will enable the United States to compete successfully with other countries. Figure 2 shows boll, fiber, and seed of an improved upland variety of cotton.

Large areas in the United States are now producing cottons of very short staple that must compete with similar types from India and other countries. While some of these sections are more or less arid and do not seem to be adapted to the production of long-staple uplands, there is ample evidence to indicate definitely that cottons of longer and more uniform staple than they are now growing can be produced if breeders are given an opportunity to develop strains suited to local conditions.

There is also the question of improving the grade and quality of the crop by breeding strains better suited to harvesting methods practiced in different parts of the Cotton Belt. Mechanical harvesters for cotton are still in the experimental stage, but it is entirely possible that the mechanical picker might be made much more effective if types of cotton better adapted to this method of harvesting were bred. Some types are already in existence that might fit into such a development.

The intensive study now being made of 16 types of cotton grown at 14 widely separated localities throughout the main Cotton Belt is also taking into account the composition of cottonseed. It is known that the oil content of the seed of different varieties of cotton varies greatly, and there is some evidence that it is influenced by growth conditions. This opens up an important field of study, and there is every reason to believe that results might be obtained by the application of scientific breeding methods to the problem. The matter of breeding cottons of special staple length and character to meet different manufacturing needs is also a promising field for breeders. The United States annually imports approximately 100,000 bales or $10,000,000 worth of Egyptian cotton for the manufacture of certain finer fabrics. There is every reason to believe that the breeder could develop long-staple upland cottons or American-Egyptian types which might put this industry on a self-sufficient basis in the United States. While the development of rapid-fruiting, early maturing varieties has in a measure solved the boll weevil problem, there would seem to be an opportunity for further improvement by intensive study of plant and boll characters that might offer resistance to weevil attack.

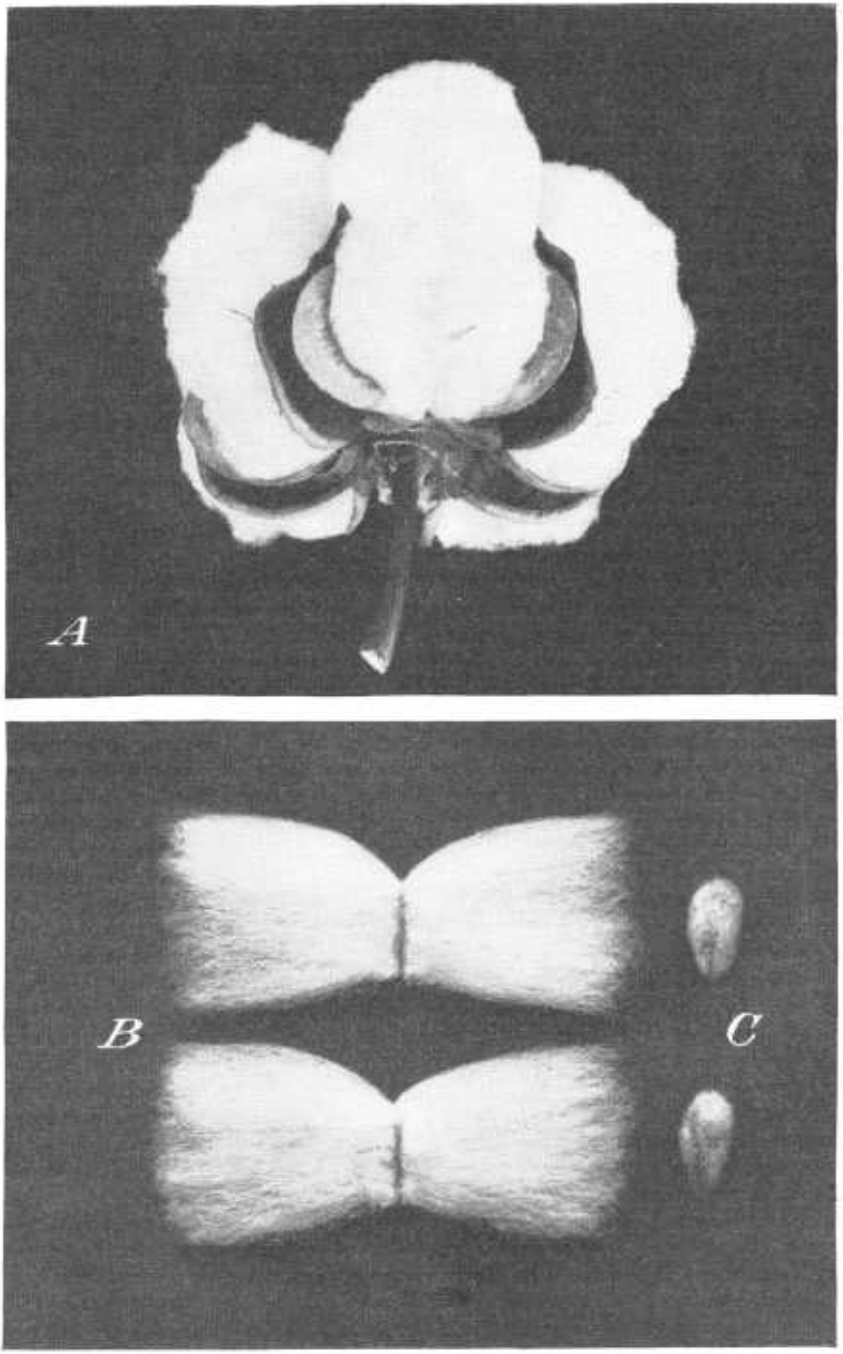

FIGURE 2.—An improved upland variety of cotton: *A*, Open cotton boll; *B*, combed fiber on the seeds; *C*, two seeds. Natural size.

In view of the many problems connected with developing and producing cottons better suited to domestic and foreign demand, more productive, and better adapted to the different climatic and soil conditions in various sections of the Cotton Belt, the Department in 1935 set up a preliminary cotton research program which includes a wide range of projects. As a background for some of the future research work, the series of regional variety experiments noted above is affording extensive studies of the influence of climate, soil, season, and other factors on the adaptation and production of these varieties, and on the quality and spinning value of the product. A genetic and breeding research program has been organized providing for fundamental genetic research or for breeding and improvement work

THE present foreign-trade situation is such that it is necessary for the United States to move forward more rapidly in breeding and improvement work and produce better cotton than is grown anywhere else in the world. The possibilities open to scientific breeding include the development of cotton of longer and more uniform staple length to meet local conditions in the Cotton Belt; the breeding of types better adapted to mechanical harvesting methods; the production of cottons of special staple lengths to meet special manufacturing needs—$10,000,000 worth of Egyptian cotton is now imported annually by manufacturers for this purpose; improvement in the oil content of cottonseed; and further improvement in resistance to the attacks of the boll weevil.

in each State across the belt from North Carolina to California. All of this work is in cooperation with the agricultural colleges and experiment stations and is closely coordinated with cotton work in the Bureau of Agricultural Economics, Bureau of Agricultural Engineering, and Bureau of Chemistry and Soils. The breeding and improvement not only involves yield and quality but is also concerned with harvesting factors, the ease with which the cotton can be ginned and prepared for spinning, and the performance of the fiber when put to the final test in manufacturing processes.

A Survey of a Century and a Quarter of Work by Private Breeders

REFERENCE has already been made to the early sea-island breeders. They were undoubtedly pioneers in this field. While the fine cottons they produced have in a large measure disappeared, the methods they followed were in some instances at least passed on to breeders of a later day. Reference to some of the later sea-island breeders is included in the section which discusses the breeding work done by the United States Department of Agriculture.

Reference has also been made to the introduction of the Mexican stock by Walter Burling at Natchez, Miss., in 1806, and its subsequent introduction into South Carolina, about 1816. This variety seems to have continued through the years and was being bred as Mexican Big Boll by J. D. Hope of Sharon, S. C., in 1914, when R. Y. Winters secured seed as foundation stock for his breeding work in North Carolina.

Between 1830 and 1840 H. W. Vick of Vicksburg, Miss., possessed a variety designated as Belle Creole and described as having a long soft fiber, large productive stalks, and large long bolls. He selected from this a new variety, Jethro, which he sent to J. V. Jones of Henderson, Ga., in 1846, and which became the parent stock of Jones Long Staple, Six-Oaks, and other similar varieties. About 1840 Vick introduced another variety called Petit Gulf which became popular about 1846, and persisted in some localities until the appearance of the boll weevil. This variety was distributed in Georgia and Alabama and was probably the parent of several later varieties in these regions.

Boyd Prolific was one of the oldest upland varieties known to have been developed from a single plant. The original plant was found in a field of ordinary cotton by a Mr. Boyd. The variety, which was common in Mississippi about 1847, was described as semicluster with short fruiting branches, medium-size bolls, and short lint. In Georgia it became a parent of Dickson and other important varieties.

The variety known as Bohemian was developed about 1865 by a Bohemian settler named Supak, who lived near Austin, Tex. This cotton was known also by the name Supak and was apparently developed by some method of plant selection. It was a rather stable type and was prominent and popular in Texas for 40 or 50 years. The bolls were large and turned down on opening, thus protecting the lint in bad weather. The broad segments of the bur and the large involucral bracts also had a roofing effect over the closely clinging locks. In spite of the storm-resistant features the cotton was easily picked. The staple length was about fifteen-sixteenths of an inch. Bohemian is of historic importance now in that it is the progenitor of Rowden and of Express.

Among other famous varieties of the early days might be mentioned Parker, Bancroft Herlong, and Peterkin. Parker was originated in 1868 at Maxime, Miss., by John M. Parker, Sr., by selection from

some variety the name of which was not given. This variety was continued by careful selection and was rather widely grown for 30 to 40 years. It was one of the old bender types, famous for high quality in the early period of cotton culture in the Mississippi Valley.

Bancroft Herlong was originated about 1868. A Mr. Herlong in Alabama sent a dozen seeds to the editor of the Southern Cultivator, who gave them to Edward Bancroft of Athens, Ga. The variety was never very uniform, but it became the parent of several other important varieties through natural crossing and straight selection. It was widely grown for probably a quarter of a century.

The Peterkin variety, which was of the Rio Grande type, was originated about 1870 by J. A. Peterkin of Fort Motte, S. C., the seed having come to him from the "back part of Texas." This variety and its later derivatives have been considered preeminent for poor soil, for land with low moisture-holding capacity, and for generally hard conditions of culture.

AN EXAMPLE OF MODERN TECHNIQUE 75 YEARS AGO

It has been reported that John Griffin, of Greenville, Miss., produced the variety called Griffin from a cross of an old upland variety, known as Green Seed, and sea island. The objective was to produce green-seeded cotton with longer and finer fiber, and the variety was established in 1867. An opinion rather prevalent among growers, especially in the earlier period of cotton production, was that green seed was a mark of hardiness or yielding ability in cotton. The work is a remarkable example of cotton breeding because John Griffin at that early date employed what is essentially the back-cross method, approximately 50 years before the geneticists proved the method to be a scientifically sound one for present-day plant improvement.

With this work, which was begun about 1857, selection was practiced 5 years before hybridization was begun and was also continued on the parental lines while the steps in crossing were carried out. Extreme hybrid vigor was reported in the first generation; according to modern genetics this is pronounced in most crosses between species of cotton. The F_1 or first-generation hybrids were 12 to 16 feet high and very unfruitful. The F_1 was back-crossed on the green-seeded parental line by using the pollen of the latter. The offspring of each succeeding back-cross was pollinated by the constantly improved green-seeded parental line for 4 or 5 years. Because of the gradual disappearance of hybrid vigor and the use of the continuous back-crossing, the plants were reduced in size, and the fruitfulness was brought back to practically that of the green-seeded parent. Every successive cross from the green-seeded parental line made on the hybrid material was to stalks least resembling the sea island form but most nearly approximating the sea island lint. In order to keep the new variety pure, selection was practiced without intermission from the time of its establishment in 1867 to the end of the century.

The Griffin variety was one of the best of the upland long-staple cottons. However, it was not sufficiently early in fruiting and maturity to persist under boll-weevil conditions. Consequently this variety was no longer successful, and this was also the case with the other late-growing long-staple upland varieties so prominent in the Mississippi Valley prior to the advent of this destructive insect.

RECENT AND PRESENT-DAY WORK BY PRIVATE BREEDERS

Since the period of this early foundation work, which lasted to about 1870, private breeders have been very active and have developed a large number of varieties and strains. These are listed in historical order, with brief summaries, in the appendix (p. 732). Among the private productions that have made cotton history during this long period—many of which became parents of later strains or varieties—were Jackson Round Boll, Truitt, Cleveland, Jackson Limbless, Russell, Toole, Cook Improved, Boykin Stormproof, Mebane Triumph, Allen Long Staple, Sunflower, Half and Half, Rowden, Wannamaker-Cleveland, the Coker varieties and strains, the Delta & Pine Land strains, the Stoneville strains, certain Acala and Lone Star strains, etc.

A few private organizations have carried on breeding work over a long period of time on a large or relatively large scale and have produced several different lines of cotton.

A new variety of cotton was bred and introduced by A. D. Mebane of Lockhart, Tex., in 1900 and named Mebane Triumph by Seaman A. Knapp. Development and maintenance of this variety represents the longest continued work in the history of upland cotton in this country. A splendid combination of high productivity, stormproofness, big bolls, medium staple length, high quality of fiber, high lint percentage, and sufficient earliness to meet boll weevil conditions in the western area, the variety has served as foundation stock for newer strains and as parental material in some important hybrids. A. D. Mebane began his work in 1882 but did not market seed to any extent until about 1900.

During the first few years after 1882, Mebane studied existing types and varieties of cotton of his section of the country and concluded that although some of the smaller boll varieties ginned out a higher lint percentage, the big-boll storm-resistant type, such as Texas Stormproof, Bohemian, Myers, and a few others, represented more nearly the type required for that part of the Cotton Belt. Presumably he finally chose stocks of Texas Stormproof or Boykin Stormproof for his material. After the stocks were chosen in the early 1880's, they were never changed and are still maintained by his family on the original estate. However, Mebane did shift the ideal toward which he was working. About 1910 he began to select for longer staple, and in due time the length was increased to $1\frac{1}{16}$ to $1\frac{3}{16}$ inches. Along with this development was associated less stability, lower yield, and less gin outturn. At the time of his death in 1923, Mebane had begun to work back to a type with higher yields, better lint percentage, and a full inch staple. Since that date, Mrs. Mebane, Paul M. Mebane, and W. P. Patton, Jr., have continued the work.

When H. J. Webber, of the United States Department of Agriculture and some of his associates began cotton breeding and improvement work in 1898, D. R. Coker, of Hartsville, S. C., became interested in having a part of the program conducted on the farms of his father, J. L. Coker.

The Federal workers were interested in developing a long-staple cotton that could be grown in the main Cotton Belt and would supply the United States with the type of cotton at that time imported from Egypt in large quantities. Efforts to grow Egyptian varieties,

previously attempted from time to time, were renewed, and trials were made to hybridize Egyptian and sea island with upland varieties. Some of this work was done on the Coker plantations.

After it was found that the Egyptian varieties were unsuitable for the main Cotton Belt and that the hybridization of the species was of little promise, Webber and his associates and cooperators turned to the development of longer fiber through selection of upland varieties. The plants with the longest staple were propagated by the plant-to-row method. Those that bred true were further tested and multiplied. Among the varieties and strains thus developed were Hartsville, Columbia (fig. 3), Webber, Deltatype Webber, Lightning Express, Super Seven, Wilds, the Coker Cleveland strains, Farm Relief, Coker Clevewilt, and Coker Foster. These are summarized in the appendix (p. 736).

BEFORE strains of cotton highly resistant to wilt fungus were developed, there were large areas in the Southeast that could not safely be planted to cotton. As a result of the breeder's work, it can now be grown without danger from the wilt hazard in every section of the South. Another result of breeding has been an improvement in the average staple length of the entire crop of approximately one thirty-second of an inch. Interpreted in terms of premiums and discounts prevailing in 1935, this meant an increased value for the 1935 crop of about 80 cents a bale, or a total of approximately $8,000,000.

In 1934, 14,775 plant selections were made by the plant-breeding staff of the Coker's Pedigreed Seed Co. About 3,500 of the best of these were placed in plant-to-row tests in 1935. In addition, about 125 strains in first-, second-, and third-year increase blocks and fields were carried. Eight variety tests were conducted. About 50 acres are devoted to the variety and plant-to-row tests and a much larger area to the preliminary increasing of strains.

Plants selected for plant-to-row testing or strains for further development must measure up, in the judgment of the plant breeders,[1] to the length, uniformity, strength, and character desired in the contemplated variety. A seed-increase field of the variety, Farm Relief, is shown in figure 4.

As has been noted, H. J. Webber supplied the method or system of breeding and some of the original material and for many years

[1] The present plant-breeding staff of the Coker's Pedigreed Seed Co. are George J. Wilds, J. B. Norton, R. S. Cathcart, R. McDick, B. E. Smith, and E. H. Larrimore.

was a plant-breeding consultant for the company. In 1920 and 1921 he was employed as general manager and headed the plant-breeding staff.

S. Pressly Coker, a cousin of D. R. Coker, was a plant breeder for the company from July 1911 until 1920, when he organized the Humphrey-Coker Seed Co. at Hartsville. Since that date he has developed and distributed several scientifically bred varieties and strains of cotton, including Cleveland 20, Dixie 14, Carolina Foster, Delta 36, Cleveland 52, and Dixie Triumph 4.

Developments in Mississippi

The private cotton-breeding work in Mississippi has been closely allied with the Mississippi Agricultural Experiment Station from the standpoint of origin of breeding stocks utilized and the personnel employed. E. C. Ewing, cotton breeder for the Mississippi Station from 1911 to 1915, during the last year joined the Delta & Pine Land Co. of Mississippi, at Scott, to breed varieties more suitable for planting in the areas used by the company (fig. 5). J. W. Fox, who had been in charge of the Mississippi Station's branch station at Stoneville and later was director of the Mississippi Agricultural Experiment Station, had preceded Ewing in joining the Delta & Pine Land Co. to be general manager of farming operations. G. B. Walker, a later director of the Delta branch station at Stoneville, and H. B. Brown, who succeeded Ewing at the Mississippi Station as cotton breeder, both left the services of the Mississippi Station in 1922 and organized the Stoneville Pedigreed Seed Co. Ewing and Brown each obtained breeding lines from the Mississippi Agricultural Experiment Station.

On beginning the breeding program in 1915, L. K. Salsbury, president of the Delta & Pine Land Co., more or less prescribed the kind of cotton that Fox and Ewing should develop. It was to have the following characteristics: The earliness of Express; 1⅛-inch staple on hill or upland and 1$\frac{3}{16}$-inch on Delta land; bolls medium to large, five-lock, easily picked; gin outturn, at least one-third; lint strong, with high spinning value; plants wilt-resistant, somewhat semicluster, strong enough to support heavy fruiting, which must be early, persistent, continuous, not ceasing in midseason.

A combination of the good qualities of Express and Wannamaker-Cleveland, with the undesirable characteristics of both eliminated, appeared to be the objective sought.

While employed by the Mississippi Station, Ewing had made a number of crosses in the summer of 1914 between Express 15 and a selected strain of Wannamaker-Cleveland, as well as many crosses of these with other varieties and strains, and other crosses among these varieties and strains themselves. With the approval of the director of the station, a portion of the hybrid seed was taken to Scott when Ewing took up commercial breeding in 1915. The remaining stock was left with H. B. Brown. In subsequent years the progenies removed to Scott were studied by Ewing and the poorer combinations eliminated. Also from year to year new hybrids were produced and observed, and the less promising discarded. Some of these hybrids were intercrossed, and thus a rather complex set of hybrids was built up in certain cases. However, back-crossing in the strict sense was not followed. Individual plant selections from the superior hybrid stocks were made and the new strains developed by plant-to-

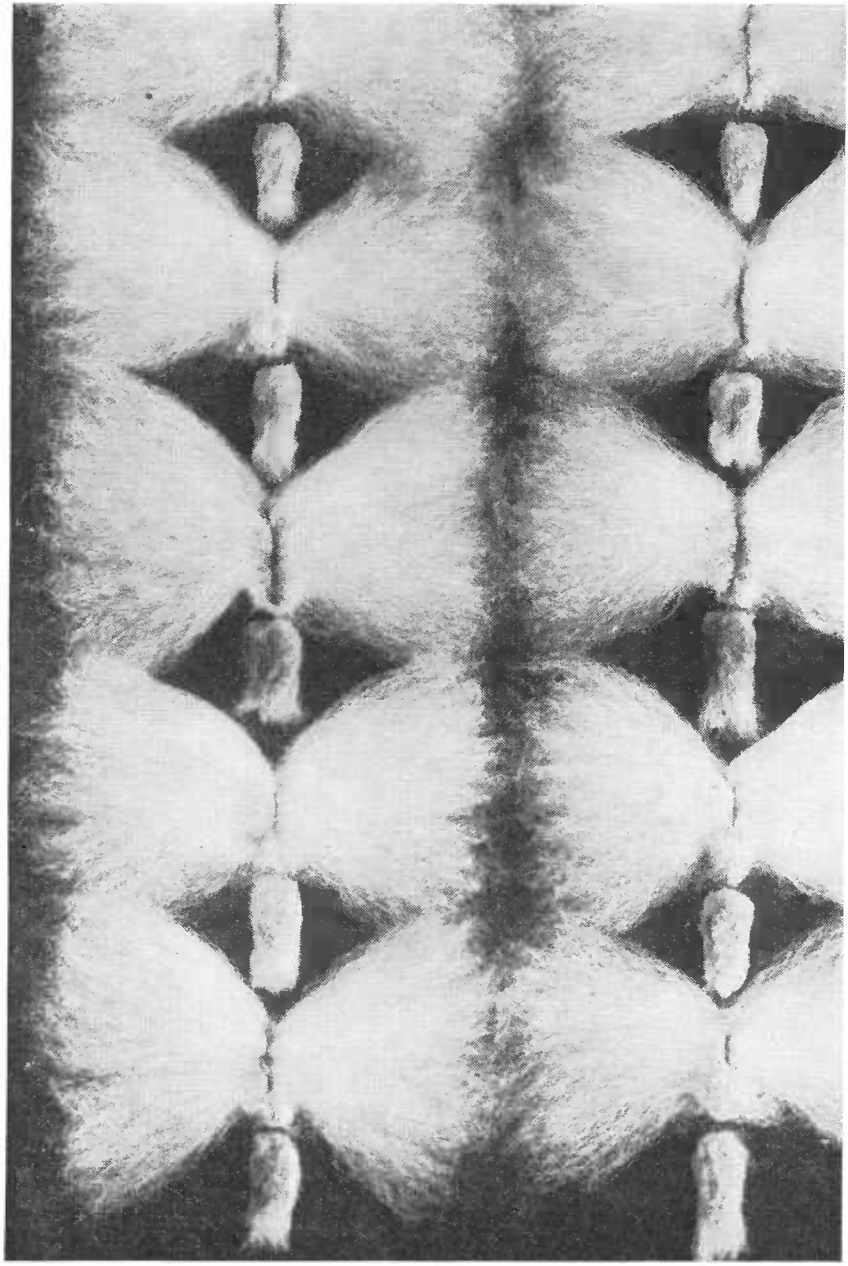

FIGURE 3.—Columbia cotton as selected from a good progeny row, 1910. Natural size.

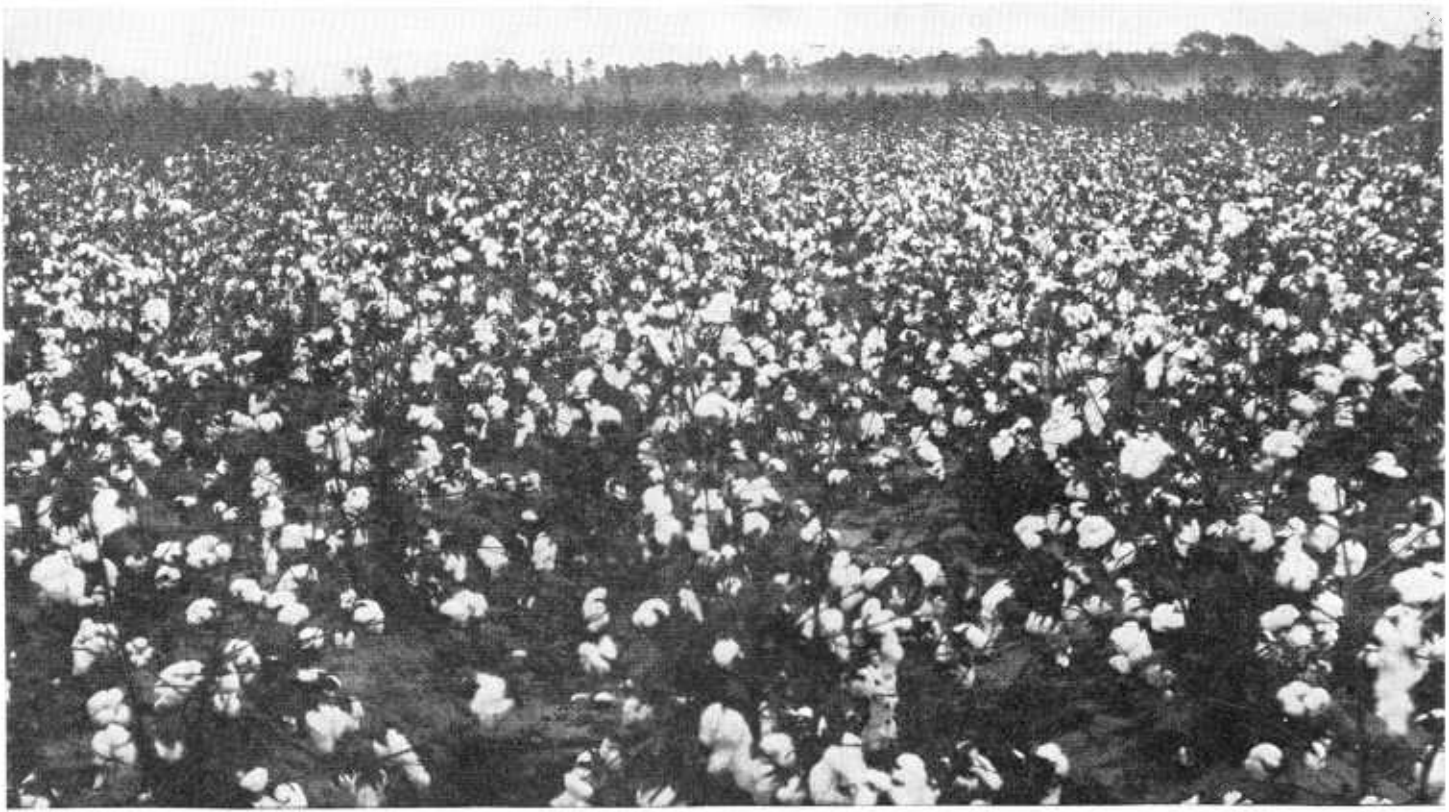

FIGURE 4.—A seed-increase field of a selected variety of cotton, Farm Relief, developed at Hartsville, S. C.

row testing and subsequent strain trials. The preliminary crossing and recrossing all were leading toward bringing out new strains and varieties.

The first product of this breeding and improvement program that seemed most nearly to meet the original specifications was the Salsbury strain or variety. All later strains or varieties also are of hybrid origin, coming from the 1914, 1915, and subsequent crosses. They include Delta & Pine Land 4, 6, 8, 10, 11, and 11 A (p. 738).

The Stoneville Pedigreed Seed Co. has bred, produced, and distributed Stoneville and certain strains of the Delfos 6102 type of cotton. H. B. Brown, assisted by C. A. Tate, conducted the breeding work from 1922 to 1926, when he joined the staff of the Louisiana Agricultural Experiment Station. Since 1926 C. A. Tate and G. B. Walker have carried on the breeding and improvement efforts them-

FIGURE 5.—Wagonloads of seed cotton at a private gin of a large cotton plantation, Scott, Miss.

selves. The seed stocks with which the company's breeding and improvement work was started were obtained, as noted above, from the Mississippi Station.

Stoneville, Rowden, and Other Famous Types

The Stoneville type of cotton is descended from Lone Star 65, selected in 1916 by H. B. Brown from an older Lone Star strain known as Lone Star 11.[2] Lone Star 65 was thought by Brown to be a natural cross with Mississippi Station Trice. Delfos 6102, now known as the Delfos type, is descended from a selection of Foster 120 made by Brown in 1916. Foster 120 in turn was a selection of Foster made in 1911. Lone Star 65 and Stoneville stocks have been continuously selected under open-pollination conditions since 1916, and Delfos stocks since 1911. The Stoneville type is a more or less general-purpose cotton adapted to a wide area. The Delfos type is suited to special areas like the bottom lands of the Mississippi Valley.

[2] Lone Star 11 was one of 3 strains selected by Ewing in 1911 from the original Lone Star, the others being no. 15 and no. 132.

The history of these two types is summarized under the names Stoneville and Delfos in the appendix.

Several commercial breeders and seed growers have operated in Arkansas, breeding and developing their own seed stocks, growing stocks bred by the Arkansas Agricultural Experiment Station, or utilizing both sources for pedigreed material.

About 1919 Robert L. Dortch began the production of pedigreed planting-seed stocks and the development of new strains out of these stocks. Dortch's first work was with the Meade and Express 350 varieties, but these stocks were later discarded and replaced by Arkansas Rowden 40. In 1923 the Arkansas Agricultural Experiment Station placed on the Dortch plantation 12 strains of Rowden which had been selected from Texas Rowden by J. O. Ware at the station farm near Scott. These strains, which were seed of first-year progeny rows, were planted in adjacent blocks. The 1923 season was a very unfavorable year in Arkansas from the standpoint of heavy weevil damage, leaf-worm injury, and shedding of fruit forms caused by rainy weather. Four of the 12 strains, designated as Rowden 1, Rowden 14, Rowden 25, and Rowden 40, stood out through these rigorous conditions as being distinctly superior, but all were subsequently discarded except the last. From 1927 to 1931 very successful crops of Rowden 40 were grown by Dortch, and the seed was widely distributed in Arkansas as well as in other States. The experiment station also grew and distributed the seed and designated the variety as Arkansas Rowden 40.

During the period from 1925 to 1931, additional Arkansas Station strains of Rowden were tried on the Dortch plantation, and Dortch continued his own breeding work with Rowden selections. Two superior strains have been bred and developed since 1926. In 1932 one of these, Roldo Rowden 40–2–9, replaced the parent stocks and is now widely grown in Arkansas and also to a considerable extent in some of the surrounding States. The other new strain is designated as Roldo Rowden 40–9–F–6–3–1 and probably will replace the former strain on the Dortch properties in 1937.

The recent strain, Rogers Improved Acala, produced and grown by John D. Rogers and J. H. McDonald at Navasota, Tex., is one of the best representative lines of the Acala 8 type. Rogers Improved Acala was first introduced commercially about 1923. Rogers began his breeding work in 1921, was assisted in 1922 by Henry Dunlavy, and has been assisted since then by J. H. McDonald. Several strains of the Acala 8 type have been introduced under the trade name of Rogers Improved Acala, but in 1931 a much improved strain replaced all previous stocks. This strain is more productive and has more round-nosed bolls and a gin outturn 4 or 5 percent higher than any of the previous Rogers lines. Rogers obtained his original breeding stocks, as noted elsewhere, from Department of Agriculture workers and from other private agencies who were growing pure seed of Acala.

In addition to those mentioned, a number of other private breeders and seed growers have operated in Texas, some of them over a comparatively long period of time. During the present century and particularly since 1920, these operators have produced and distributed cotton planting seed widely not only in Texas but in several of the surrounding States.

Among the new lines developed from such parentage as Lone Star, Mebane Triumph, Rowden, and Acala, are New Boykin, Ferguson

Triumph 406, Buckelew Mebane, Kasch, Bennett Lone Star, Lankart, Bryant Mebane, Sunshine, H–X, Russell, Worley Boykin, Young Improved Acala, Harper, Paris Big Boll, Qualla, Hurley Special, Cliett Superior, Hasselfield Lone Star, Texas Special, Chapman Ranch Mebane, Wacona, Aldridge A–1, Texas Mammoth, Bagley Better Cotton, and Watson. These are summarized in the appendix.

The Development of Acala 5 in Oklahoma

Several commercial cottonseed firms have grown and distributed planting seed in Oklahoma. One of these firms, operated by the late C. N. Nunn, was responsible for the development of the present Acala 5 type of cotton.

In the spring of 1914 D. A. Saunders of the United States Department of Agriculture sent a bushel of Acala seed to C. N. Nunn, then county agent at Okemah. Under Nunn's supervision, the seed was planted on an acre of land on the farm of L. A. Niells and isolated. In the fall of 1914 O. F. Cook, D. A. Saunders, and others of the Department visited this plot. With Nunn, they selected 96 plants which Nunn planted in progeny rows in the spring of 1915 on the Lynde & Darby farm near Porter. Nunn at that time had resigned as county agent and had become partner and manager in the Lynde & Darby farming operations.

Through the help of some of the Department cotton breeders, Nunn selected two of the best rows, no. 5 and no. 8, in the fall of 1915. D. A. Saunders preferred row 8 because of its similarity to the original Acala and returned all the seed production of this row to Clarksville, Tex. Nunn preferred row 5 as more suitable for conditions in Oklahoma because of its earliness. This was the beginning of the Acala 5 type. All other Department strains as well as the stocks of row 8 later became known as the Acala 8 type. Nunn put Acala 5 on the market as planting seed in 1918. It was distributed extensively in Oklahoma, Arkansas, and to some extent in the northern part of Texas until about 1927, when Nunn's new strain, Acala 5–37, replaced the parent strains in the Nunn's Pedigreed Seed & Stock Farm plantings. Shortly before his death in 1934, Nunn had developed and introduced a later strain called Nucala, shown in figure 6. Nunn made a distinct contribution to the cotton industry in developing, preserving, and distributing the Acala 5 type of cotton. His work provided breeding stocks of Acala for the Oklahoma, Arkansas, and Tennessee Agricultural Experiment Stations, and foundation stock for cottonseed companies in Oklahoma, Arkansas, and New Mexico.

Cotton Breeding in the Department of Agriculture From 1867 to 1936

THE effort made by the United States Department of Agriculture to provide improved or more suitable varieties of cotton for the Cotton Belt consisted mainly in the importation of foreign stocks until practically the beginning of the present century, when breeding

work with existing American varieties was begun by H. J. Webber, W. A. Orton, and their associates. During the latter half of the past century Department workers had worked especially with Egyptian cotton. Both Webber and Orton retested some of the Egyptian varieties, and the former attempted to adapt these varieties to the main Cotton Belt by applying more systematic methods of breeding than had been tried previously.

The much-increased interest of foreign spinners in Egyptian cotton, brought about by the cotton famine of the American Civil War, created a feeling that it might be necessary to grow this cotton here in order to recapture the trade that had temporarily shifted from the United States to Egypt. In 1867 the Department of Agriculture began the importation of cottonseed from Egypt and the distribution of small trial lots of this seed to many points in the South. Results of more than 50 experiments with the Egyptian cotton during the following 5-year period in various parts of the Cotton Belt were recorded, but most of these tests showed total failure and none was sufficiently successful to indicate that the cotton could be grown to advantage in the main Cotton Belt. After this series of failures about 20 years elapsed before Egyptian cotton was tried again by the Department of Agriculture.

About 1890, importations of Egyptian cotton at high prices by American mills stimulated a demand on the part of certain interests that the culture of Egyptian varieties be tried again. Between 1892 and 1894, seed of three of the varieties most prominent in Egypt at the time were imported and distributed in all the cotton States by C. R. Dodge. All plantings were discontinued and the stocks lost after the first trial except in one case at Floresville, Tex., where, because of the long season, W. H. Wentworth matured a good crop, continued plantings, and selected for acclimatization and adaptation for several years until he obtained a product apparently of high quality. However, after developing the seed stock, he had difficulty in making actual sales of the commodity and finally discontinued the undertaking.

In the latter part of the nineties L. H. Dewey imported more Egyptian cottonseed, had it distributed, and in one instance obtained a manufacturing test of the fiber. The test was made by the Ponemah Mills at Taftsville, Conn., with cotton of the Jannovitch variety grown by Robert Viewig of Godwinville, Ga. However, American mills still did not like American-grown Egyptian cotton and continued to get their supplies from abroad.

After H. J. Webber was put in charge of the plant-breeding work of the Department of Agriculture in 1897, he continued the trials of Egyptian cotton in the Cotton Belt and extended the tests to some of the river valleys of the Southwest, where irrigation could be practiced and where climatic conditions were similar to those of the Nile Valley. Webber selected plants for adaptation from year to year, using the Egyptian stocks that remained from Dewey's importation. He also worked with fresh stocks brought in from Egypt by David Fairchild, then in charge of foreign plant introductions. This new material was represented by the varieties Mit Afifi, Ashmouni, Jannovitch, Abbasi, and Gordon Pasha, and they were planted at many points all the way across the Cotton Belt from South Carolina to California. Plant-to-row breeding for adaptation was practiced, and experimental success was attained at several places, notably, Harts-

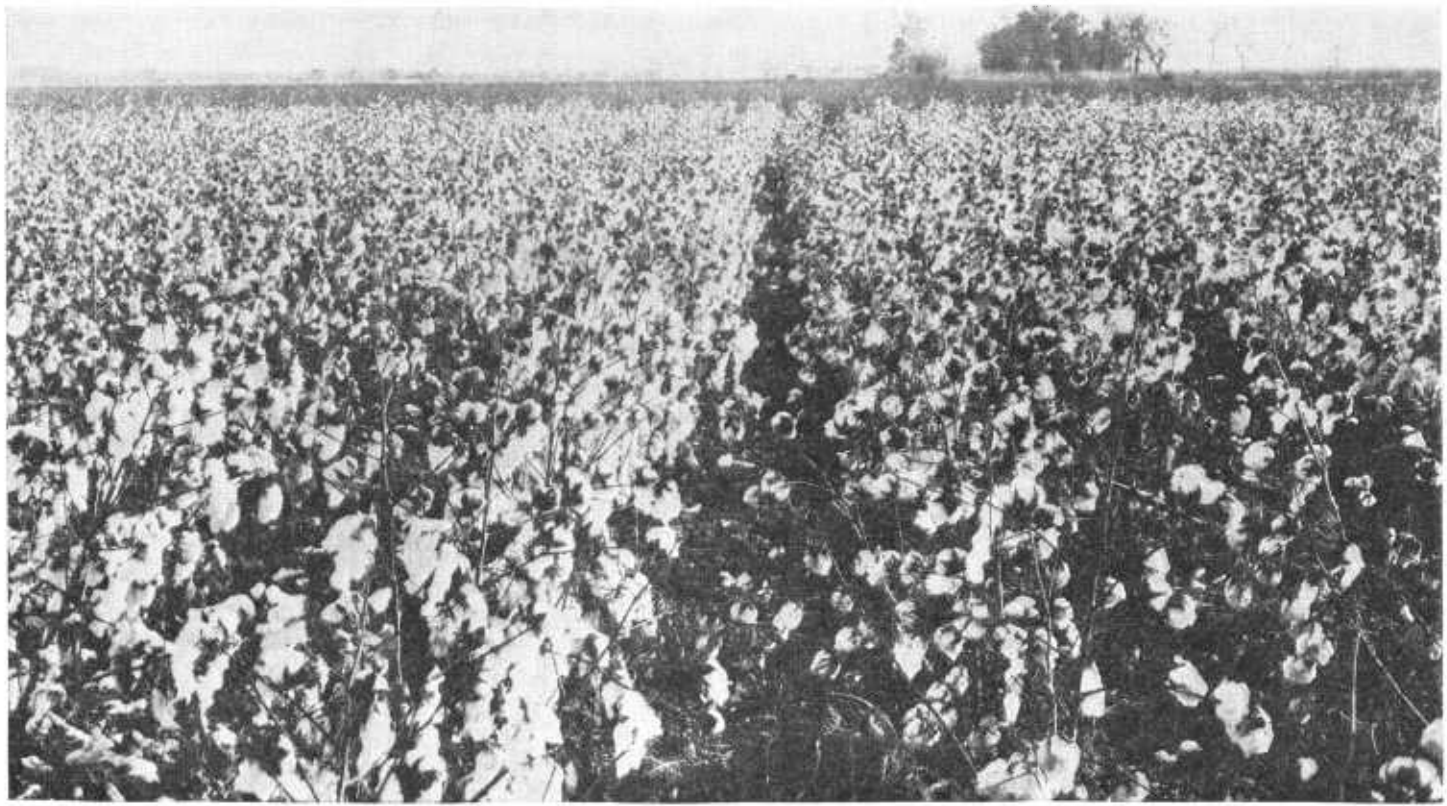

FIGURE 6.—A field of Nucala cotton, a recent strain of Acala developed at Porter, Okla.

ville, S. C.; Maxime, Miss.; San Antonio, Brownsville, and Del Rio, Tex; Carlsbad, N. Mex.; Yuma, Ariz.; and Calexico, Calif.

However, in the main Cotton Belt, where growers were accustomed to big-boll upland and where Egyptian in the long run is not suitable as a rain-grown crop, production did not extend beyond the experimental stage. Bacterial blight or black arm attacked Egyptian cotton seriously in the humid area and was one of the more important reasons why this type of cotton was not continued further in experiments in the East. The work was discontinued soon after 1900 except in the irrigated valleys of the Southwest, where prospects for developing a successful industry were better. T. H. Kearney, who was an associate of Webber's and was working on crops adapted to saline soils in the irrigated sections, became interested in the Egyptian-cotton adaptation studies in the Southwest and went to Egypt in 1902 to study the culture of cotton there. On his return he took over the breeding stocks maintained to that date by Webber [3] and continued the Egyptian-cotton breeding work begun by his predecessor. A more detailed discussion of this development will be given later in this article.

In the beginning of his cotton-improvement work, Webber studied the painstaking methods used by the sea-island growers to keep up the quality of their crops, and utilized them with some adaptation.[4] He carried on the isolation of long-staple strains of upland cotton mainly in South Carolina, at Columbia and at Hartsville. His assistants and associates worked at various points in the main Cotton Belt to develop upland varieties either with better staple or with better adaptation to boll weevil conditions, the latter work being confined at this time to the western end of the main Cotton Belt, especially in northwestern Louisiana and Texas.

The history of the long-staple upland varieties that were developed at Hartsville, S. C., has previously been referred to in connection with the discussion of the breeding work of the Coker's Pedigreed Seed Co. Webber developed the Columbia variety and D. N. Shoemaker assisted in breeding the Hartsville variety. In Webber's 1902 trials, several plants of the Russell variety were found to have extra long staple—these perhaps being natural hybrids—and Columbia was developed from the one plant with the longest staple (1⅜ inches).

In his experiments on the plantation of R. C. Keenan at Columbia in 1903, Webber found a few plants of Jones Improved with lint from 1⅛ to 1¼ inches in length. From these he developed Keenan after five generations of selection and testing. The lint of the new variety was slightly coarser and shorter than that of Columbia, and uniformity of fiber length was less well established, but Keenan became known as a useful variety. It was fairly early and productive and had bolls that opened well.

The work of D. N. Shoemaker in assisting in the development of the Hartsville long-staple variety was done in 1903 while he was

[3] In 1900 Webber grew about 3 acres of Mit Afifi in the Imperial Valley, Calif., on land where Calexico now stands. This was the first year water was turned into the irrigation canal and the cotton was the first grown in the valley. A number of selections were made from this patch, which marked the real beginning of the American-Egyptian industry in this country.

[4] A summary of the cotton-breeding personnel in the immediately succeeding period is of some historical interest. 1897-1907, H. J. Webber carried on cotton breeding in the Department; in 1899 W. A. Orton, in another division of the Bureau of Plant Industry, began work on cotton wilt, cooperating closely with Webber; in 1900 T. H. Kearney began work with Webber, and started work with Egyptian cotton in the Southwest in 1903; in 1904 D. N. Shoemaker began work with Webber and in 1908 he succeeded Webber in cotton breeding and continued until 1910; in 1911 O. F. Cook took over the cotton investigations of Webber and Shoemaker.

located in Hartsville, S. C., as a teacher of botany in a local school and cotton breeder for D. R. Coker. W. C. Coker, a botanist at the University of North Carolina, Chapel Hill—brother of D. R. Coker—had made 30 plant selections out of a field of Jones Improved grown on the Coker farm at Hartsville the year before, 1902. Plant selection in these early days is illustrated in figure 7. In 1903 the selections were planted on the Coker Plantation and supervised by Shoemaker. In 1904 this breeding work was taken over by D. R. Coker, who continued to select the breeding lines until one of them was isolated as the most outstanding. This strain was called Hartsville. It was closely related to Keenan and was also related to Columbia. The staple of Hartsville measured $1\frac{1}{8}$ to $1\frac{3}{16}$ inches and was very uniform, both in length and strength. However, after the boll weevil arrived in South Carolina, Hartsville was replaced, along with Keenan and Columbia, by earlier varieties.

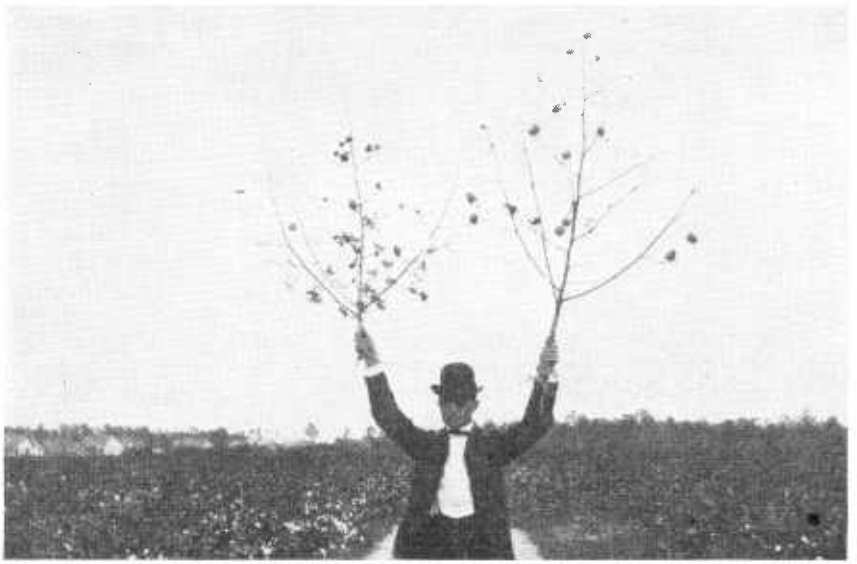

FIGURE 7.—Photograph taken more than 30 years ago, showing two individual plant selections made out of the Jones Improved variety at Hartsville, S. C., during the early cotton breeding work of H. J. Webber and his associates.

BREEDING EXPRESS AND LONE STAR, AND WORK WITH OTHER FOUNDATION STOCKS

Express was developed by Shoemaker shortly after his appointment with the Department of Agriculture in 1904, when he was sent to Texas to work on the development of earlier varieties of cotton to meet boll weevil conditions and also to improve staple quality and length. In the fall of 1904 he found a single prolific early plant with good staple in a field of mixed cotton, thought to be chiefly the Bohemian variety, near Paris, Tex. Called Express because of its speed in fruiting and maturing, the strain developed from this plant reproduced the character for rather extreme earliness in a remarkably uniform manner and the longer staple quality to a marked degree. However, the bolls were small and not storm-resistant, so that the

type did not appeal to Texas farmers, who were interested in big bolls and storm resistance. Seed stock was carried along and grown to some extent for further observation until 1910, when E. C. Ewing obtained some of the seed and developed the variety in the Mississippi Delta.

A. W. Edson began cotton-breeding work in Texas in 1901. His efforts, like those of other Department workers, consisted chiefly in developing earlier strains with better staple than the existing or parental varieties possessed. Several strains of King were produced with fiber ranging in length from 1⅛ to 1¼ inches. However, like Express, these were not well received by Texas farmers and were not cultivated to any extent. The development of several early strains of the Big Boll and Stormproof group of Texas varieties was started by Edson before his death in 1905.

The efforts of F. J. Tyler while employed in the Department of Agriculture did not concern cotton breeding and improvement work directly but were devoted to a comprehensive effort at the identification of the upland varieties and their relative economic importance and classification. In this work 613 varieties and synonyms were described or listed.

The work of D. A. Saunders was concerned with cotton breeding and improvement in the main Cotton Belt States west of the Mississippi River, chiefly in northwestern Louisiana and in Texas. He developed the Lone Star, Foster, and Holdon varieties, and assisted in the breeding of others. He also supervised the multiplication and distribution of pure cottonseed stocks and was the first superintendent of the United States Cotton Breeding Station at Greenville, Tex., in 1918.

The development of Lone Star, named for the Lone Star State, began in 1905, when D. A. Saunders selected some plants individually from a field of cotton—understood to be a variety known as Jackson—located in the Colorado River bottoms near Smithfield, Tex. The variety was doubtless from stocks of Jackson Round Boll. One strain, isolated by plant-to-row testing in 1906 and 1907, had a short-jointed main stem, rather early fruiting tendencies for the Texas Big Boll group, large and blunt-pointed bolls, lint 1 to 1⅛ inches, very strong and uniform in length, and a gin outturn of 38 to 40 percent. This strain was tested at several points in Texas, multiplied, and introduced to farmers in 1909 as Lone Star. It has been very prominent in Texas, and to some extent in parts of surrounding States, since that date, and has served as foundation stock for a number of other Lone Star strains and hybrids, notably Stoneville.

In his early work, Saunders also made crosses between Texas Big Boll varieties and eastern varieties which were earlier or had longer staple. One of his crosses, made in 1904 near Shreveport, La., between Mebane Triumph and Sunflower, has become famous as the beginning of one of the most important groups of cotton of the present time.

The object in making this cross was to develop a medium long-staple variety with as large bolls as possible and also sufficiently early to produce profitable yields under boll-weevil conditions. Plants were selected from the hybridized material and grown in separate rows on the farm of J. F. Foster, of Shreveport, La. Several years were required to establish the kind of strain sought and to purify it of aberrant forms. Throughout the development period the selec-

tion was carried out under conditions of heavy weevil infestation, so that the type of plant that could best survive stood out markedly. Though as yet not entirely pure, the variety was introduced to some extent in 1909 and given the name of Foster, after which it was subjected to further selection. Foster never became very important in Texas, but it spread eastward and soon became prominent and extensively grown in the large river valleys. In 1911, E. C. Ewing introduced it into Mississippi and used it as part of his foundation stock for further breeding.

TWO FAMOUS COTTONS—DURANGO AND TRICE

At the St. Louis Exposition in 1904, F. L. Lewton observed some excellent cotton plants and bolls in an exhibit placed there by the Mexican Government. This material was supposed to have come from the State of Durango, Mexico. Lewton obtained a small

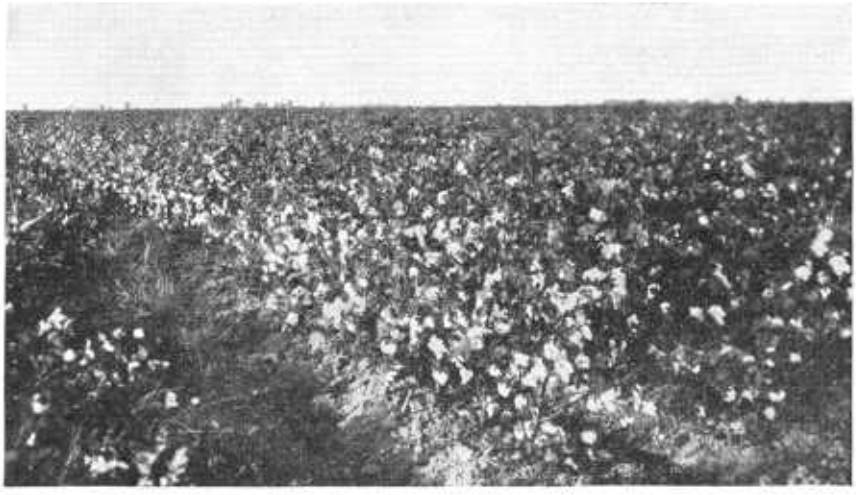

FIGURE 8.—Field of cotton showing progeny rows at El Centro, Calif. Durango (upland) variety, 1912

quantity of seed from the Mexican representative in charge of the exhibit, and in 1905 a few of them were planted at several points in south Texas, chiefly at Del Rio and San Antonio. In 1907, at Del Rio, a superior strain was recognized and during the next few years isolated and multiplied. In 1911 trials of the new acclimatized strain, which had become known at that time as Durango, were made in various places in the Cotton Belt. It was thought, however, to be more suitable for south Texas and the Southwest, and consequently was tried out in the district around Del Rio and in the Imperial Valley of California (fig. 8) more than in other parts of the country.

In the Imperial Valley in 1911, three acres of Durango were grown on the farm of W. E. Wilsie near El Centro. About 200 acres were planted around El Centro and Holtville in 1912. By 1913 the Durango variety had become very popular in the Imperial Valley, and California farmers not only planted all the seed from the 200 acres grown in 1912 but obtained all the pure seed stocks that were available in Texas. As developed in the Imperial Valley, it became the

first upland variety to be grown on the one-variety community basis. It also did well in many of the upland long-staple areas of the humid part of the Cotton Belt and was grown to a considerable extent in some of the large river valleys until it was replaced by Express and Delfos. In the irrigated districts of Texas and the Southwest it was the most popular upland cotton until it was replaced by Acala.

From 1904 to 1919 S. M. Bain, of the Tennessee Agricultural Experiment Station, Knoxville, served as a collaborator in the Bureau of Plant Industry, working on the breeding and development of early and more productive varieties of cotton with better staple length, and making laboratory and other experimental tests with the breeding material used. Oil analysis was made to determine whether or not the oil content could be increased by breeding. Ovules and pollen were chemically treated to determine the effects, if any, on the progeny. Albert T. Anders, an employee of the Department from 1907 to 1915, for a time assisted Bain in this work.

As far as breeding and improvement work is concerned, Bain and Anders are chiefly remembered for the development of the Trice variety from plants selected by Bain in 1904 in a field of early cotton on the farm of Luke Trice near Henderson in Chester County, Tenn. After several years of selection and testing, by 1908 much improvement over the original variety was exhibited in all the qualities sought as well as in uniformity. The plant was small, very early, very prolific, boll medium size, lint percentage 28 to 33, staple fine and seven-eighths to fifteen-sixteenths of an inch in length. Trice was earlier than King and was superior to this variety in size of boll and length of fiber.

Trice was very popular for almost a quarter of a century along the northern rim of the Cotton Belt. Its tendency not to develop excessive vegetation on soils with abundant nitrogen and moisture made it popular for newly cleared land and low bottom lands. During the worst part of the boll weevil era, Trice spread farther south, especially in the central part of the Cotton Belt. In this period E. C. Ewing and H. B. Brown of the Mississippi Agricultural Experiment Station developed a strain of Trice called Mississippi Station Trice. J. O. Ware of Arkansas and Glen Briggs and L. L. Ligon of Oklahoma also developed strains of the variety. The stock of Trice was maintained by Bain and Anders in Tennessee during their service with the Department of Agriculture, through cooperation with seed-grower farmers. W. W. Ballard and D. M. Simpson of the Department have maintained strains of Trice since 1919.[5]

THE FIGHT AGAINST THE WILT FUNGUS

In 1895 the cotton wilt disease had spread to an alarming extent over the territory where sea island cotton was being grown. The growers called on the United States Department of Agriculture for assistance. Erwin F. Smith responded, going to James Island, S. C. (fig. 9), and spending 4 weeks on W. G. Hinson's farm investigating the nature and cause of the disease. During the same year E. L. Rivers, a neighbor of Hinson's, resorted to the old sea island system of selection as a

[5] A few commercial breeders in the territory where Trice has been popular have assisted in the preservation of the variety, have developed more recent strains, and have distributed the seeds widely. A. F. & J. F. Bridger of Bells, Tenn., and the Burdette Plantation, Burdette, Ark., are notable in this respect. J. F. Bridger discontinued his work only a few years ago, but the Burdette Plantation still produces some Trice seed. Some of the strains developed by this firm and by the Arkansas Agricultural Experiment Station have produced a staple length of 1 to 1 1/16 inches and a lint percentage of 33 to 34.

means of developing a wilt-resistant variety. The seed of the first plant selected in 1895 was multiplied on badly infested land in 1896 and in 1897. At the end of the 2-year period the new strain possessed a satisfactory degree of wilt resistance, but the fiber did not come up to the standard for the sea island commodity, either in uniformity of length or in general quality. The strain was abandoned and efforts to find a desirable single plant in Rivers' fields were resumed. In 1899 such a promising specimen was obtained.

Cotton wilt had also occurred in many sections of the upland cotton areas of the Southeast. The presence of this problem both in sea island and upland territory had caused Congress to make an appropriation for the Department of Agriculture to study and devise control measures. The Department promptly gave attention to the problem. In 1898, H. J. Webber visited James Island, consulted with Hinson

FIGURE 9.—Field of sea island cotton as grown on the islands off the coast of South Carolina before the passing of this industry in the United States.

and Rivers, and inspected the latter's selection work, and in 1899 W. A. Orton went to the island and urged Rivers to continue his work.

Many experiments such as seed treatments and soil treatments with varying quantities of lime or fertilizer were devised by Orton and tried out for wilt control by cooperating farmers on James and Edisto Islands in 1900. None had any effect on the disease.

In connection with these experiments on his farm in 1900, Rivers planted the seed of his 1899 selection as controls on some badly infected land that was untreated. The progeny from this selected plant was fully resistant and the lint produced proved to be commercially satisfactory. In 1900, Webber and Orton urged him to multiply the strain. One acre was planted in 1901 and 15 acres in 1902. At the end of the latter year, Orton, through the United States Department of Agriculture, purchased a large part of the seed from Rivers and distributed quantities to other sea island growers. This strain was known as the Rivers variety.

Orton and Rivers together selected a second variety which was resistant to wilt and coarser in quality of fiber than the Rivers variety.

The object was to combine with wilt resistance greater productiveness and general hardiness rather than especially long staple. The variety was designed more particularly for the mainland of Georgia and Florida, where the finest quality and longest staples were not so important as good yields, hardiness, and disease resistance. In 1900 Orton selected the first plants out of a field of sea island infested with wilt on Edisto Island, and in 1901 grew a plot planted from these selections on the same farm. In 1902 the stock was transferred to James Island and planted in a wilt-infested field on E. L. Rivers' place. After further selection, in 1903 one row proved to be outstanding for wilt resistance, general productive characteristics, and uniformity of staple, but the fiber was somewhat shorter and coarser than the island type. This row was propagated and became the Centerville variety, named after the Rivers place, which was called Centerville Plantation. The Centerville variety became an important wilt-resistant one for the sea island cotton farms of the mainland.

At the time Webber and Orton became interested in the wilt problem in sea island cotton, Orton also began work in wilt-infested areas of upland territory, especially one in the upper Coastal Plain of South Carolina around Dillon and Lamar, and another in southeastern Alabama around Troy and Headland. The wilt disease was more prevalent in these two general areas at that time but was also known to occur to a less marked extent in eastern and southern Georgia and had been reported in Florida and in Arkansas.

At first Orton followed the same general plan tried with sea island—seed treatments, fertilizer and lime tests, and variety comparisons. Study soon indicated that the only practical solution for control of the disease was the breeding of wilt-resistant varieties. Orton's early experience indicated that mass selection did not suffice but that individual plants must be obtained from inherently resistant stocks and grown by the progeny row method on wilt-infested land. This was necessary not only to obtain a high degree of resistance but to maintain the necessary uniformity in plant growth factors and in staple quality.

Development of Wilt-Resistant Upland Varieties

In 1900 an experiment was started by Orton on the farm of H. L. Galloway of Dillon, S. C. The field was heavily infested with the disease. In this experiment, plots of local varieties as well as varieties brought in from other localities were tried. Among the varieties introduced were three Egyptian and one sea island. The highest degree of resistance was found in the three Egyptian varieties. Jackson Limbless, an upland variety, ranked fourth. Sea island ranked fifth, and showed considerably more damage. There were 13 other upland varieties included which were all much less resistant than Jackson Limbless or the others; several were very susceptible to the disease. Selection and retesting of the more resistant plants of the Jackson Limbless stock were continued until 1905, when it was introduced as a new variety under the name of Dillon, after the place where the work was done.

Dillon was the first upland wilt-resistant variety developed by systematic methods. It was extremely resistant to wilt and somewhat resistant to root knot, but had little else to recommend it. It was an extreme cluster type, shed badly during dry spells, was

hard to pick and produced staple of about seven-eighths of an inch. After Dillon was introduced, however, it was widely grown and was used as a parent in a number of hybrids with other upland varieties to introduce wilt resistance.

The second wilt-resistant variety was developed at Troy, Ala., by the plant-to-row method from selections originally made in 1902 on wilt-infested land. One strain from Peterkin, presumably a hybrid with some other variety, eventually proved to be uniform and highly resistant to wilt. The type of plant finally developed had the pyramidal habit of branching like Peterkin, and this made it better liked than Dillon. The new variety was called Dixie and was a considerable improvement in earliness, size of boll, and lint percentage over the old Peterkin.

W. W. Gilbert began work with the Department of Agriculture in 1904 as assistant to W. A. Orton on the cotton-wilt problem. L. O. Watson, as an agent working with H. W. Barre at the South Carolina Agricultural Experiment Station from 1911 to 1914, assisted with the breeding for resistance. In 1914 Watson took up full-time work with the Department and kept on with the project in the Southeast until it was discontinued in 1920. C. A. McLendon replaced Watson at the South Carolina Station in 1914 and for 2 years assisted Watson in the cotton wilt work after Gilbert left it.

The development of Dixie suggested the importance of hybridization as a method of obtaining wilt-resistant varieties. The need for varieties with as much rapidity in fruiting and general earliness as possible, in addition to wilt resistance, was suggested by the advance of the boll weevil from the west. It was desired that a variety with larger bolls, longer lint, and a higher lint percentage than either Dillon or Dixie be developed. In 1908, 1909, and 1911 a large number of hybrids were made between Dillon and Dixie and between these varieties and several of the larger-bolled, early varieties that had been successfully grown in boll weevil areas or had characteristics that apparently would be suitable under such conditions. These varieties were Triumph, Cook, Pride of Georgia, Columbia, Webber, Foster, and Trook (a hybrid between Trice and Cook).

The leading variety developed out of this work was Dixie-Triumph. This is still an important wilt-resistant variety and is being bred at present by commercial breeders in South Carolina and by the Louisiana and Arkansas Agricultural Experiment Stations. Dixie-Cook was another new variety developed out of this work, but it did not enjoy the popularity of Dixie-Triumph.

Another important wilt-resistant variety developed by selection in Alabama was Cook 307–6. This variety was introduced in 1913 and subsequently disseminated widely in the wilt-infested sections of Alabama. The development of the variety was accomplished through the cooperative effort of Gilbert, Watson, and the Alabama Station. H. B. Tisdale, employed jointly by the office of Cotton and Truck Crop Diseases and the Alabama Station from 1914 to 1920, worked on the breeding and the distribution in Alabama of the wilt-resistant varieties Dixie, Dixie-Cook, and Dixie-Triumph. However, it was found that none of these responded to conditions in that State as readily as the Cook 307–6.

The sueeess of the wilt-resistanee work of the Department with upland eottons had stimulated State eooperation in South Carolina, Georgia, and Alabama, and also interested farmers and seed firms in seed produetion and in breeding on their own aeeount. During the latter portion of their serviees with the Department and coop-

FIGURE 10.—On the slopes of the mountains of eastern Guatemala the native Kekchi Indians planted small patches of cotton, and, under the protection of the kelep ants, good yields of fiber were regularly obtained for homespuns, 1905.

erating institutions, Watson, McLendon, and Tisdale devoted most of their efforts to supervising the produetion and distribution of wilt-resistant varieties grown or bred by private eooperative growers and breeders.

While on a trip to portions of Central America in 1902 O. F. Cook, who was then in charge of investigations of tropical agriculture in the Department, observed among the Kekchi Indians (fig. 10) of eastern Guatemala, a dwarfy upland kind of cotton which was apparently much less injured by the boll weevil than was a nearby tree of a perennial cotton. This interesting fact was reported back to the Department, and 2 years later an expedition was sent to study the nature of varieties of cotton grown by the Guatemala Indians under weevil conditions. The season in 1904 had been much more rainy than in 1902, and the small, dwarfish, annual variety cultivated by the Kekchi Indians exhibited plants of larger size and much more promising appearance. A few weevils were found on this cotton, but they apparently were being held in check by some agency. Investigation showed that in fact several agencies protected the plants from severe weevil damage. One was an insect, the so-called kelep or Guatemalan cotton boll weevil ant, which was predatory on the boll weevil and was attracted to this type of cotton by the large production of nectar from two sets of extra floral nectaries on the involucral bracts.

FIGURE 11.—A single plant of the native Kekchi cotton in Guatemala showing large crop of bolls, 1905.

Several features of the plant itself worked together in an extraordinary manner to give it protection. In addition to the excessive and extended flow of nectar which attracted the kelep, this cotton had the habit of rapid growing and early fruiting. Protective morphological structures other than the nectar glands were the effective proliferation or abnormal growth of tissues in young buds and bolls attacked by the weevils; the small involucral bracts; and excessive hairiness over the plant surface. The rapid growth of the tissues around the punctures where the weevil eggs were laid and around the larvae served to close in on the young insects and kill them. In other districts of Guatemala native cottons were obtained with the small involucral bracts that enabled turkeys to find the weevils and devour them. A single plant of the native Kekchi cotton is shown in figure 11.

Seed of some of the most promising Kekchi cottons were sent to H. J. Webber and were planted in 1905 not only in south Texas but

at some other points in the United States. When planted at Pierce, Victoria, and several other points in Texas the Kekchi cotton was rank in growth and showed great diversity in plant and fruit characters. Several of the more luxuriant plants remained completely sterile; others produced a few bolls near the end of the season. On the other hand, in northern localities in Kansas and Maryland the plants were small, there was not as much diversity in type, and some of them matured fruit. Some of the plants which produced a few mature seeds were continuously propagated and the better individuals were selected until a definitely adapted productive type was obtained. However, no strains sufficiently superior to existing

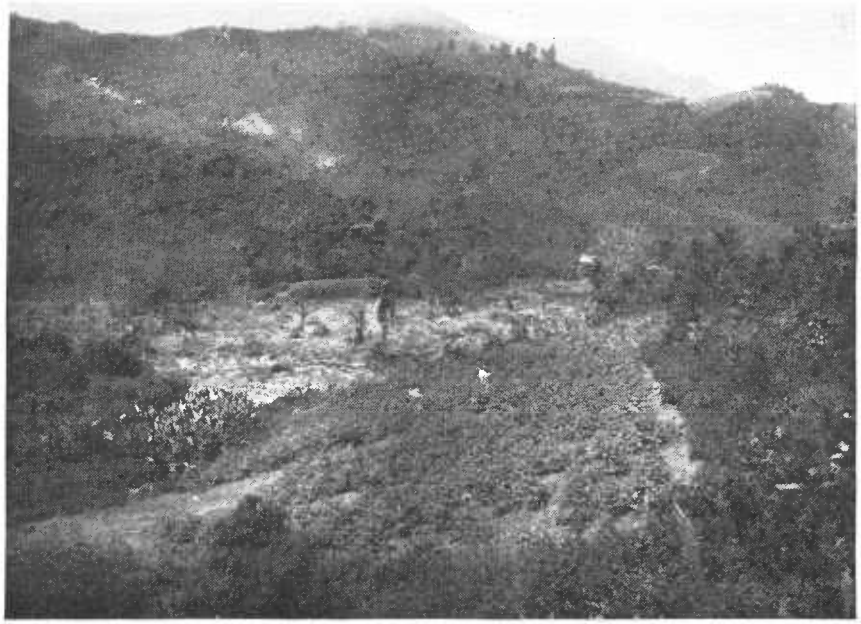

FIGURE 12.—An experimental field of cotton in Eastern Guatemala, where several varieties of cotton popular in the Unted States were grown by Department specialists for comparison with the native Kekchi cotton, and for further studies of the kelep or boll weevil ant, 1905.

American varieties or to certain other introduced and acclimatized sorts ever came out of Kekchi to justify a general introduction, though it has been a local favorite in several districts. A few adapted strains of Kekchi have been continued by the Department until the present time in order to preserve the type and have it available for breeding material if some of its special characteristics should prove valuable for meeting particular requirements.

Several other types previously observed in the weevil-infested districts of eastern Guatemala were brought into south Texas and into southern California during a few years after 1905. Other parts of Central America and southern Mexico also were explored during this period for cottons which were persisting in the presence of boll weevils. An experimental planting of United States varieties was made in eastern Guatemala (fig. 12).

Introduction of Acala from Mexico

The seeds of two types of upland cotton, which later became known as Acala and Tuxtla, respectively, were obtained by G. N. Collins and C. B. Doyle when on a trip in southern Mexico (fig. 13) in the winter of 1906 and 1907 investigating cotton culture under boll weevil conditions in that region. The seeds of these were included in the acclimatization experiments at Victoria, Kerrville, and Del Rio in 1907, along with other foreign stocks being studied in south Texas during that period. The two stocks were each selected for adaptation through a period of years. However, the Tuxtla sort was never multiplied and distributed to farmers.[6]

Little difficulty was encountered in acclimatizing the Acala, and most of the plants were fertile and productive during their first season in Texas. At the San Antonio field station Acala was grown under conditions that demonstrated resistance to drought, ability to produce crops in a short period, and persistence among boll weevils.

FIGURE 13.—General view of small patch of cotton with owner, taken at Acala, Mexico, by G. N. Collins and C. B. Doyle, December 1906.

In 1909 an outstanding type was isolated, and in 1911 it was grown in a field near Waco, Tex. The work at Waco was in charge of D. A. Saunders. During the years 1912 and 1913 Saunders isolated three strains, designated as No. 1, No. 2, and No. 3, and also increased the bulk stock. No. 1 and No. 2 were kept in Texas, while the increase from No. 3 was the bushel lot of seed furnished C. N. Nunn at Okemah, Okla., in 1914, already mentioned.[7]

[6] When adapted and grown in this country, it appeared uniform, had a desirable staple, and still possessed the very large bolls, but the type required a growing season too long for boll-weevil conditions. Several years later it was noted that Tuxtla had possibilities in the irrigated areas of the Southwest, where boll weevils do not occur, but it never replaced the more popular Durango and Acala varieties grown there at that time. Stocks of the variety have been maintained by the Department chiefly because of the interest in preserving a seed source of a jumbo type of bolls.

[7] The stocks from the bulk lot of the 1911 Waco planting, the No. 1 and No. 2 selected stock from this Waco planting, and the No. 8 returned from Oklahoma, have all been considered in later years as belonging to the Acala 8 type in contrast with the Acala 5 type developed and propagated by Nunn. The existing stocks classified under the No. 8 type may not all be traceable to a certain definite breeding line handled by Saunders. However, the stocks used by John D. Rogers, Navasota, Tex., the Sugarland Industries, and the Sartartia plantation of Sugarland, Tex., since 1930 were developed from the No. 1 strain established by Saunders in 1912 and 1913. The last two agencies are affiliated with Rogers to the extent that the latter provides their seed stocks. Previous to 1930 the breeding lines of Acala used by Rogers and the affiliated firms had been isolated from among a collection of all Acala stocks that were available in 1922 when the breeding work was started at Allenfarm, Tex., by Henry Dunlavy, who became cotton breeder for the Rogers Co. at that time. Stocks were collected from C. N. Nunn as well as from the U. S. cotton-breeding station at Greenville, the D. A. Saunders Seed Co. of Greenville, and other sources.

During the development of Acala from about 1911 onward, a considerable acreage was grown by farmers around Clarksville and Greenville, Tex. Some of these stocks at a rather early period in their development were carried to the Southwest and tested in the irrigated valleys. The first field planting of Acala cotton in California was in 1919, at Bakersfield in the San Joaquin Valley, from seeds brought from Clarksville, Tex. A record shows that two progenies out of the Acala 8 type and three progenies out of some of the other Acala stocks grown at Clarksville were transferred to California in 1921 and continued there, where they could be better cared for because of the isolation and the breeding methods used in community production. Figures 14 and 15 show Acala cotton in California.

From the 8-acre field planting at Bakersfield in 1919, 350 acres were planted in neighboring districts in 1920. Also a small planting of this same seed was made in 1920 at the United States Experimental Date Garden near Indio, Calif. The planting at Indio stimulated the farmers of the Coachella Valley to organize for the one-variety-community production of Acala in the fall of 1920.[8]

Meade—A Superior Cotton Ruined by Mixing Seed

In 1912 Roland M. Meade selected a few exceptionally desirable plants in a field near Clarksville, Tex. The plants possessed lint over 1½ inches long and had black seeds, practically devoid of fuzz.

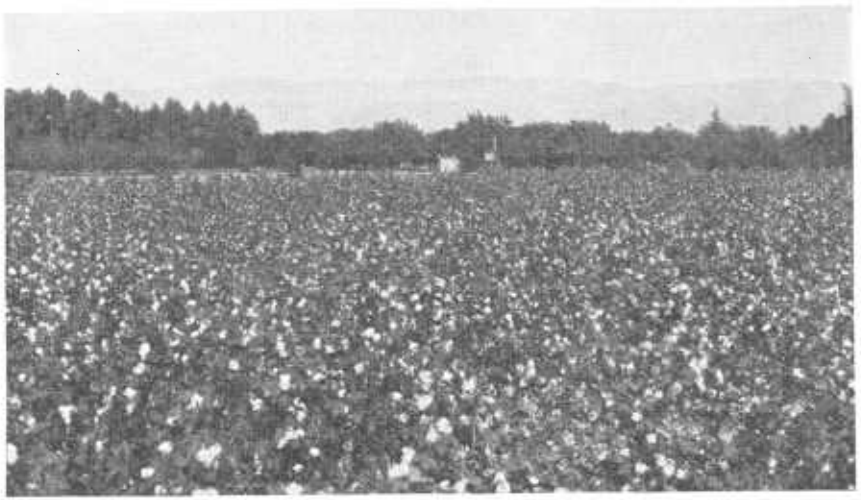

FIGURE 14.—Field of Acala cotton grown at Indio, Calif., 1921.

The fiber more nearly resembled that of sea island than had any other long-staple upland cotton before developed. The parent stock from which Meade selected his plants could not be definitely traced. At the time, the local information was that the cotton had been brought to Clarksville from Arkansas several years before. It was somewhat

[8] Such strains of Acala as California Acala, Shafter Acala, College Acala, Queen Creek Acala, Lyon Brothers Acala, Cody Lenz Acala, and Acala S–5 were developed from the stock grown in the date garden at Indio in 1920. A strain of Acala 8 in Tennessee has been developed by that station from seed of the strain designated as California. The "Slick" Seed Acala, or strain 1–13–3, came from the Shafter strain of Acala and was selected at the U. S. Field Station, Shafter, Calif. Tidewater, which was developed in the sea-island area of the Southeast, came from the strain designated Acala S–5, which was carried to James Island, S. C., about 1926 or 1927. The California and Acala S–5 strains were developed in California, the Queen Creek in Arizona, the College Acala in New Mexico, the Lyon Bros. strain at Geary, Okla., and the Cody Lenz strain at Austwell, Tex. Okra Leaf Acala and Stewart Acala were developed from some of the stocks that were transferred from Clarksville, Tex., during the early part of the distribution period of the variety.

indiscriminately referred to as Black Rattler or Blackseed, but the description did not correspond very closely to descriptions of either of these varieties as found in other sections of the Cotton Belt.[9]

Meade was the first to appreciate the possibilities of breeding a superior stock from such material, and the work was well under way at the time of his death in 1916. Three generations of progenies had been developed from selected individuals and a superior stock isolated. This superior line was named in Meade's honor. After his death, other workers in the Department of Agriculture continued the breeding work with this material.

Some of the new variety was transferred to James Island, S. C., in 1916, since it had occurred to those working with Meade that this variety might serve as a substitute for sea island, after it was found that the latter could not survive the boll weevil.

On being tried in the Southeastern States, Meade produced a staple length averaging 1⅝ inches and showed exceptional uniformity with little tendency to shortened lint at the base of the seed, the so-called "butterfly" shape. When tried under boll weevil conditions in southeastern Georgia, the yield was three or four times that of sea island. On the markets Meade lint was received in competition with sea island. Several bales were sold in 1917 on the Savannah market at a premium of a half cent a pound above the current price of mainland sea island.

FIGURE 15.—Acala cotton plant selected at Indio, Calif., 1921.

Apparently Meade was on the way to becoming a striking success. More than 10,000 acres were grown between 1920 and 1922, but mixing of seed and planting in close proximity to fuzzy-seeded upland varieties resulted in a rapid contamination in the stocks, the mixed fiber was rejected by the trade, and the variety was largely abandoned after 1925. In 1933 some breeding work was resumed on James Island with Meade, and more recently this has been continued in cooperation with the South Carolina Agricultural Experiment Station.

At the James Island Acclimatization Station and through cooperation with growers, the Department maintained and selected several sea island varieties and strains (fig. 16). These consisted of two new

[9] Tyler lists both Black Rattler and Blackseed. The former was a "quarter" cotton grown rather extensively in the Mississippi Valley previous to the boll weevil period, and the latter was a name applied generally to sea island cotton but in some sections to a smooth-seeded Peterkin, which was a short cotton.

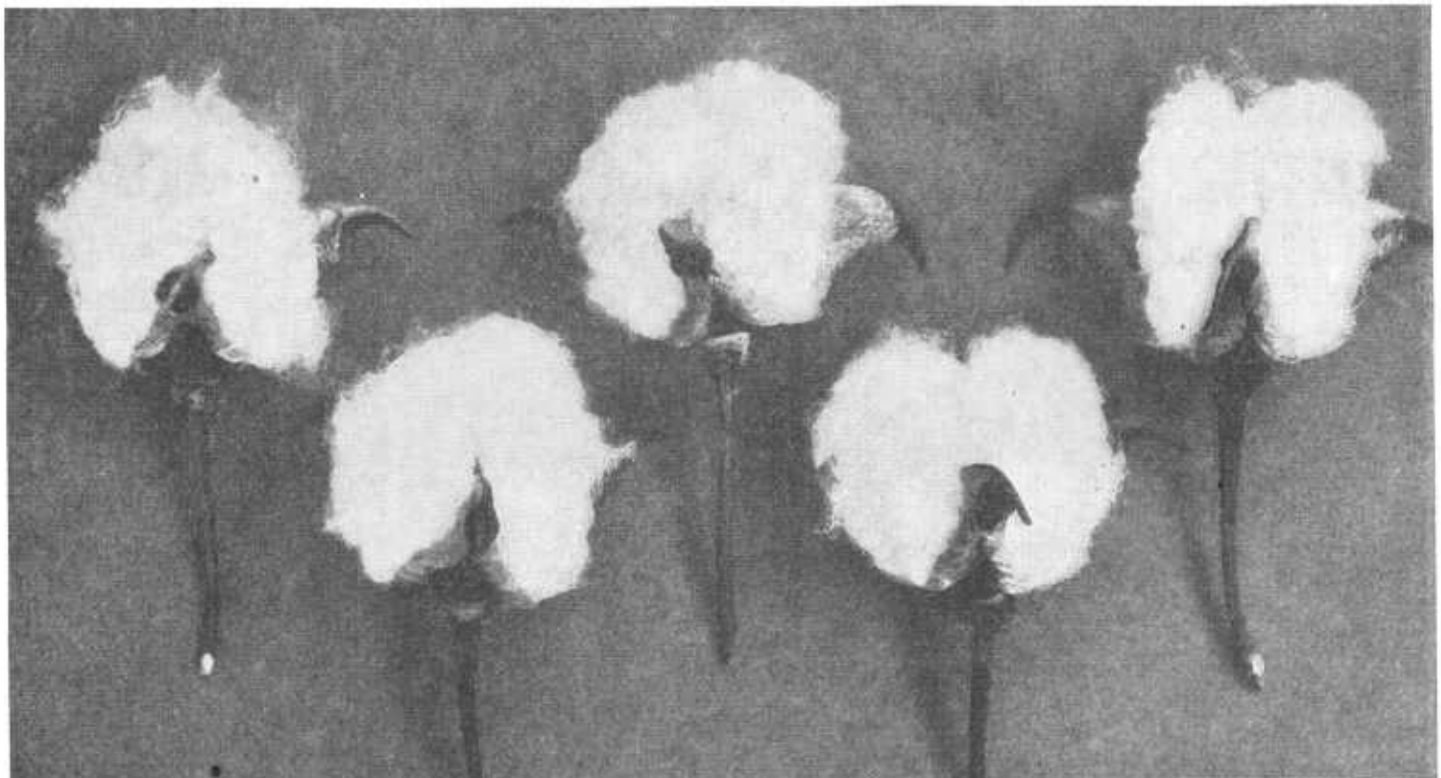

FIGURE 16.—Typical bolls of sea island cotton. Natural size.

strains developed from the old Seabrook variety, two strains of the Bleak Hall variety, and two earlier maturing shorter staple types found in Georgia and Florida and designated as Westberry and Andrews sea island. Breeding work with sea island cotton, however, was not very effective in furnishing strains that would provide any assurance of a crop under heavy infestation of boll weevils. The rind of the sea island bolls is thin and is much more easily penetrated by the beaks of the weevils than is the case with the thicker walled carpels of the upland species. Also the sea island bolls remain subject to weevil injury during the entire maturation period, while upland bolls become relatively resistant to attacks after the third week of development. Moreover, the fruiting is not sufficiently early or uniform, and the period of boll development is too long to escape devastation by the weevil.

Selections From Acala and Lone Star

As previously noted, Acala S–5 was brought from the United States Cotton Field Station, Shafter, Calif., and grown on James Island. In 1927 selections were made from the Acala S–5. Several strains were developed as a result of this breeding and designated as Tidewater. Among those that have shown the best results are Tidewater 12, Tidewater 29, and a very long-fibered strain which was developed by J. C. Seabrook of Wadmalaw, S. C., in cooperation with the Department. Selections of Tidewater were made in 1929 from which a wilt-resistant strain has been developed.

It has been pointed out that Lone Star was developed by D. A. Saunders from a selection out of Jackson Round Boll. This variety has been maintained and further selected by the Department since Saunders introduced it. The work with Lone Star since 1918 has been carried on principally at the United States Cotton Breeding Station at Greenville, Tex., and since 1919 under the direction of H. C. McNamara. Commercial breeders have obtained stocks of this variety from time to time, some merely multiplying the stocks while others carried on further line breeding. The United States Cotton Breeding Station has several strains such as D–2, H. O. 2–5–1, P4–1. The D–2 line of Lone Star has provided seed stock for the present Gonzales one-variety community, which has about 75,000 acres of cotton in Gonzales and adjoining counties in Texas. There is also quite a large acreage of this strain in north Texas. Lone Star is the foundation stock for such cottons as Bennett, Paris Big Boll, Gorham, Russell Big Boll (not the parent of Columbia), Hasselfield Lone Star, Kinsler-Hartman, H–X, Lankart, Wacona, and Startex 619. It is also one parent of some varieties of hybrid origin, such as Stoneville cotton.

In addition to the actual development of improved sorts of cotton from imported and domestic stocks, Cook and his associates devoted much effort to studies of the morphological, heritable, and physiological behavior of the plant as influenced by acclimatization tests, by different regional effects in the Cotton Belt, and by adjustments to certain cultural conditions.[10]

[10] From one or more of these standpoints, studies were made of wild forms, Hindi cotton, the diversity and the branching habit of Egyptian cotton, the general subject of the morphology of cotton branches, special morphology of branches and leaves such as dimorphic forms, arrangement of plant parts, supernumerary carpels, behavior of interspecific hybrids, kinds of hybrids in successive generations, mutative reversions and reappearance of primitive characters, suppressed and intensified hybrids, brachysm, physiological diseases and plant abnormalities caused by weevil damage, budding of incompatible species, abortive fruiting branches, weevil adaptations, transmission of various economic plant characters, and culture, especially spacing of the plants.

DEVELOPMENT OF AMERICAN-EGYPTIAN COTTON IN THE SOUTHWEST

Kearney's trip to Egypt in 1902 to study cotton culture there has already been mentioned. On his return in 1903, he and his associates made a concentrated effort to establish an Egyptian-cotton-growing industry in the irrigated districts of Arizona and southern California, where conditions were similar to those existing in the Nile Valley.

At first rather unsatisfactory yields and quality were obtained among the several imported varieties in the Southwest, but selection for better plants was continued. The persistent selection of the best plants gradually brought about some improvement in earliness, productivity, and quality of fiber, but not a great deal of progress was made until 1908, when two types were recognized and isolated from the Mit Afifi variety. These types were very different from the

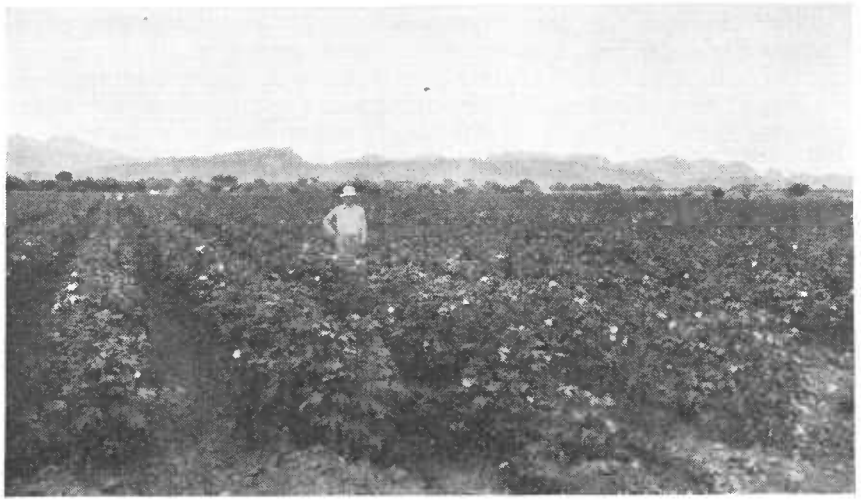

FIGURE 17.—Field of Egyptian cotton at Sacaton, Ariz., 1913.

parental variety and represented a distinct step in the acclimatization of Egyptian cotton in the Southwest. One of the new types became the Yuma variety and the other the Somerton variety. The latter, however, was soon discarded because of its lateness and excessive vegetative development.

In staple length the Yuma variety averaged about 1 1/16 inches. Field tests and also spinning tests of the fiber by manufacturers during the next few years demonstrated its suitability for commercial production. In 1912 the Department furnished seed to farmers for planting a few hundred acres in the Salt River Valley of Arizona and in the Imperial Valley of California. The acreage of American-Egyptian cotton in these areas increased rapidly during the next 5 years, and in 1917 production amounted to about 16,000 bales.

In 1910 a single plant of marked individuality was observed and selected from Yuma. The strain developed from this plant was named Pima. It was characterized by finer, lighter colored, and longer fiber than that obtained from Yuma. The staple averaged 1 1/16 inches in length. After testing for several years it was concluded

that the new variety was superior to the parent, and Pima was substituted for Yuma. Ordinarily it is difficult for a whole district to replace one variety by another without considerable mixing of seeds, but the cotton growers of the Salt River Valley were sufficiently well organized to carry out the undertaking successfully. The entire acreage of American-Egyptian cotton was changed over to Pima in 1918, and 1920 saw the largest production in a single year—over 92,000 bales. A field of Egyptian cotton is shown in figure 17.

Another variety called Gila arose from a single plant selected by E. W. Hudson in 1908 out of the old, somewhat acclimatized stocks of Mit Afifi. This variety, however, did not gain much headway.

The success of the Durango and Acala upland varieties in the Imperial Valley of California brought competition with American-Egyptian there, and as far as commercial growing is concerned, the latter type has been confined entirely to the Salt River Valley of Arizona since 1921. After 1922 upland cotton also was introduced into the Salt River Valley and has been extensively grown, but through community effort the American-Egyptian stocks have been kept pure. As a result of the expansion of upland growing, the area devoted to the culture of American-Egyptian has declined. The area planted in 1935 was 38,000 acres, with an estimated production of 17,600 bales. Pima has been maintained as the sole variety until recently, but during the past 2 years a small acreage has been planted to a new hybrid variety designated as S×P 30 and developed from a cross of Pima and Sakel (Sakellaridis). According to both mill and field tests, it appears to be superior to Pima. At the present time back-cross work with this hybrid on both the Pima and Sakel parental lines is being carried on to obtain a higher quality of fiber as well as more productivity. A typical plant of Pima is shown in figure 18.

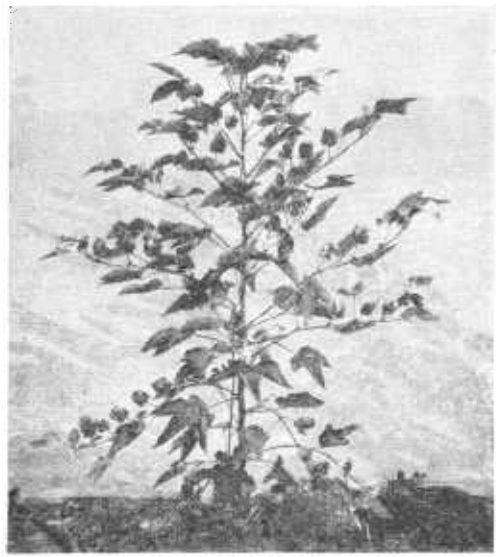

FIGURE 18.—A typical plant of the Pima Egyptian cotton grown at Sacaton, Ariz.

The work of Kearney and his associates from around 1900 to 1917 was confined to adaptation, breeding for improvement, and other research work connected with the culture of the crop. Since that period, a considerable part of their effort has been concerned with cotton genetics and a cytogenetic and taxonomic study of the cotton plant and some of its relatives. Many of these more fundamental problems presented themselves during the earlier period but were deferred because of the pressure of other needs. As a result of these researches, Kearney has become the leader in this country in the genetics of cotton and in the study of taxonomic relationships among the different species of *Gossypium* and some of their relatives.

THE ONE-VARIETY-COMMUNITY PLAN

Much of the benefit gained by bringing in new varieties and by the excellent breeding work that was done by the Department of Agriculture, private breeders, and the State experiment stations, has been

FIGURE 19.—A typical scene in the Cotton Belt of the United States, with lines of wagons loaded with seed cotton from a mixed-variety community awaiting their turn at the gin.

lost by the failure to perpetuate the best strains and varieties or to keep them free from admixture with inferior kinds (figs. 19 and 20). Realizing that this was a serious handicap to the whole cotton im-

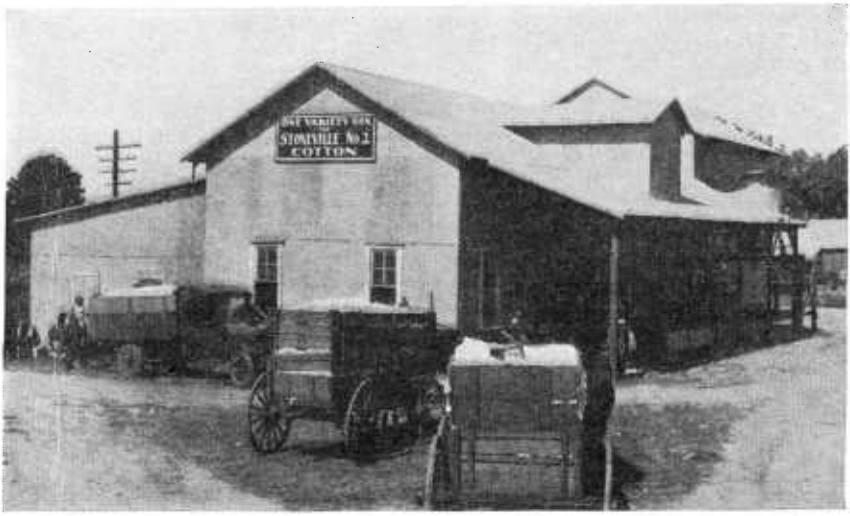

FIGURE 20.—Gin in the Orchard Hill community in Georgia, showing loads of seed cotton of one variety.

provement program, O. F. Cook proposed the one-variety-community plan and described the plan in an article published in the 1911 Yearbook entitled "Cotton Improvement on a Community Basis." The development of this plan by Cook's associates, in later years in coop-

eration with the Extension Service and the experiment stations in several of the States, has resulted in standardization of production of superior varieties and strains in many sections of the Cotton Belt. The first one-variety community began in 1912 with the distribution of the Yuma variety of Egyptian cotton in the Salt River Valley of Arizona. Two years later the North Carolina Agricultural Experiment Station began some work on a community basis. About the same time the growing of Durango was begun on a single variety basis in the Imperial Valley in California. After Acala became well established, about 1920, this variety provided seed stocks for one-variety-community work, especially in the Southwest. It practically supplanted the Durango there and was later designated by State law as the only variety that could be planted in certain sections of California.

Within the past 5 or 6 years the one-variety-community plan has been widely adopted and has resulted in keeping pure some of the best varieties produced by present-day breeders, and in their rapid increase. There were more than 300 organized communities in existence in 1935, planting nearly 800,000 acres in 156 counties and producing about 500,000 bales of improved community-grown cotton. Approximately 75,000 bales of one-variety cotton were produced in communities in Georgia alone. This type of organization fits in well with the cotton-breeding and improvement program because it facilitates keeping superior strains pure and increasing them rapidly so that they may be distributed over large areas at a minimum cost to growers. It is estimated that the better strains of the best varieties now in existence could be increased in this way to plant the entire cotton acreage of the United States within a period of 5 years. The uniformity produced by selected as compared to "gin-run" cotton is illustrated in figure 21.

A Historical Summary of Cotton Breeding at the State Experiment Stations

COTTON breeding for improvement in varieties at State institutions in the Cotton Belt was undertaken soon after State experiment stations were established, but new varieties were not produced until just after the turn of the century. The first breeding work done by land-grant colleges was in Alabama and Georgia, but the first varieties produced were at the South Carolina and Tennessee stations. At most of the stations breeding work did not begin until 1910 or later, and in a few States, in which cotton occupies only a small acreage, no program has been set up. These States have obtained their seed stocks from the more important cotton-growing areas where such work is carried on. The work in the States will be taken up in the order in which breeding efforts began.

Alabama

In 1886 P. H. Mell and C. L. Newman began to cross-pollinate cotton at the Alabama Agricultural Experiment Station. The following year this work was extended and a much larger number of

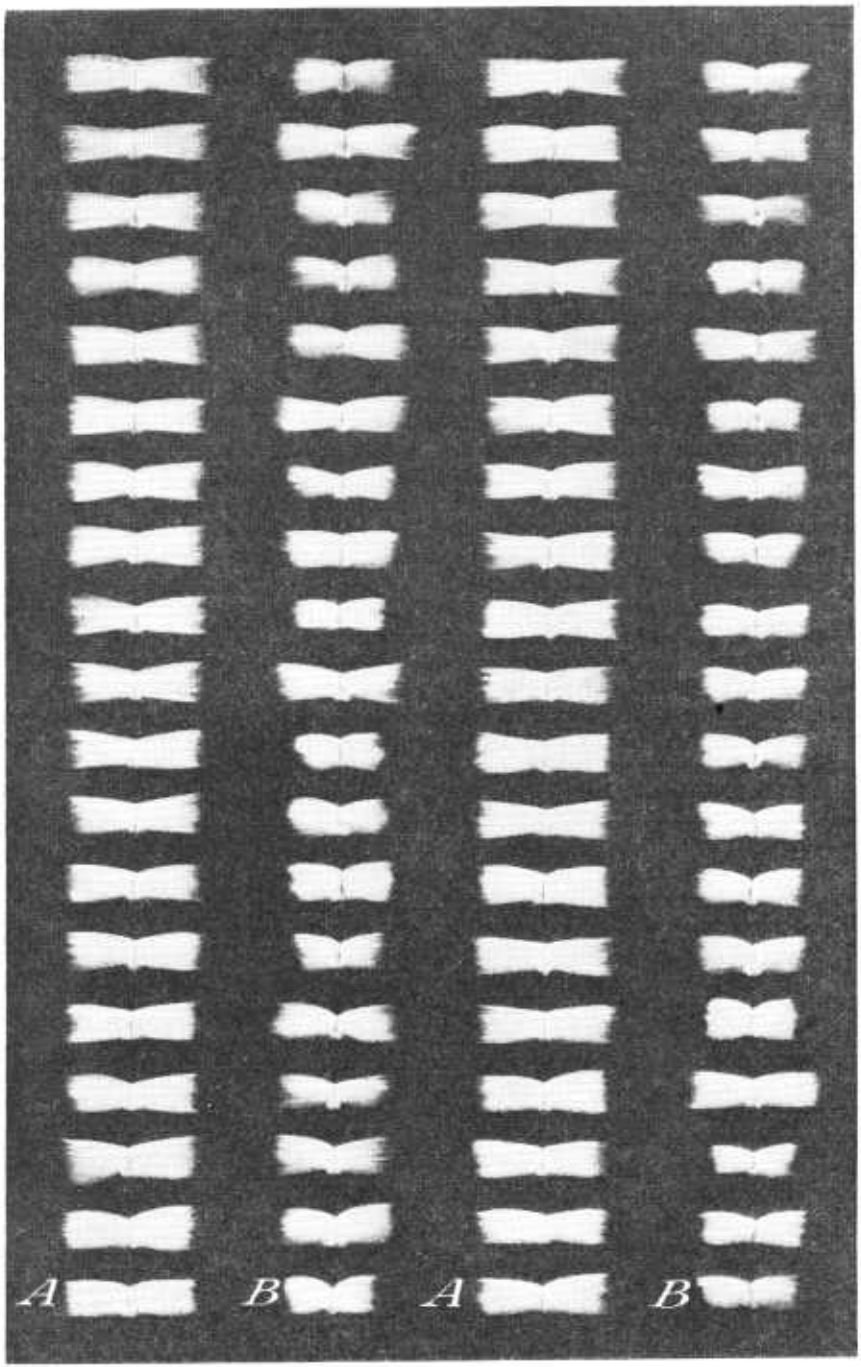

FIGURE 21.—Uniform fiber (*A*, *A*) combed on individual seeds from 19 consecutive plants in a row planted with pure seed of a select stock, compared with irregular fiber (*B*, *B*) from consecutive plants in a mixed, "gin-run" stock. Reduced.

crosses were made among several of the standard varieties of the period by Mell and E. R. Lloyd. Mell continued hybridization and the study of the resulting progenies for several years. Some of the crosses were sent to other experiment stations for testing, and one of these lots, sent to the South Carolina Station, was the stock out of which the Blue Ribbon varieties were selected later. In 1895 Mell began also to make crosses between several upland and several foreign varieties, but from the interspecific hybrids obtained no new varieties of any economic value were derived. J. S. Newman, while with the Alabama Station during this early period, carried on individual plant selection with the Peerless variety in order to purify it.

E. F. Cauthen worked with the station from 1908 to 1923. H. B. Tisdale became associated with Cauthen in 1914, working on wilt-resistant varieties as agent in cooperation with the Department of Agriculture from this date to 1920. Tisdale succeeded Cauthen in 1923, and has continued the station work in cotton breeding and improvement to the present time. About 1910, Cauthen began to select plants out of the Cook variety. Alabama Station Cook was the first strain produced; it had smaller bolls, higher lint percentage, and more uniformity than the original Cook variety. Cook 1010 was developed shortly thereafter; it had still smaller bolls, higher lint percentage, and shorter staple, and was very productive. Cook 307–6, introduced in 1913, is the parent of some commercial varieties, such as Rhyne Cook and the later wilt-resistant strains produced at the Alabama Station. A more recent wilt-resistant strain, Cook 912, developed by H. B. Tisdale, is rapidly becoming very popular in Alabama and is fast replacing other Cook stocks.

The cotton breeding and improvement program at the Alabama Station includes several newer strains of Cook and a Cook-Express cross which are being further line selected.

Georgia

Gustave Speth, horticulturist at the Georgia Experiment Station, made one of the first systematic and continuous attempts among experiment stations in the United States to improve the cotton plant by hybridization. P. H. Mell at the Alabama Station preceded him slightly. The crosses were between sea island and some of the upland varieties. The work was begun soon after the establishment of the station at Experiment, Ga., in 1889. A dozen or more hybrid lines were developed and while some of them were thought at the time to be quite promising, they finally failed, as have most later hybrids between these species. In 1893 H. N. Starnes, Speth's successor in horticulture, made crosses between several upland cottons, but the work was not carried far enough to establish and distribute new superior varieties. About the same time, J. M. Kimbrough, agriculturist at the station, began to select for improvement of the Jones Improved variety. This selection, doubtless the mass type, was continued for a decade or more. Early in the selection period, however, the stock of the reselected variety was introduced as Jones Re-improved, known after 1898 as the Schley variety.

After 1906, when the department of botany was established at the Georgia Experiment Station and R. J. H. DeLoach became botanist and pathologist, more comprehensive work in cotton breeding was undertaken by him and carried on for a number of years by his suc-

cessors. C. A. McLendon succeeded DeLoach as botanist in 1908 and occupied the position until 1913. He carried on the most comprehensive study in the inheritance of characters of the plant published in this country up to that time, 1912. (Ga. Sta. Bull. 99.)

The Georgia State Board of Entomology at Atlanta began considerable work in the study of the cotton wilt disease about 1905. This work was inaugurated by E. L. Worsham, State entomologist, and A. C. Lewis, assistant entomologist. As plant breeder for this board from 1916 to 1920, C. A. McLendon assisted in the work, but most of his time during this period was spent in testing and selecting varieties for boll weevil conditions in cooperation with individual growers in different sections of northern Georgia.

While at the Georgia Experiment Station between 1906 and 1908, DeLoach made some crosses among several varieties of upland cotton. Out of one cross between Cook Improved and Columbia, he later developed a variety, named Sunbeam, which was high-yielding and had large bolls, staple of about 1 inch, and some resistance to diseases. Further breeding work with the variety was carried on by DeLoach and later by Loy E. Rast, at Athens. From 1912 to 1914, Rast made further selections from Sunbeam that resulted in a new variety, College No. 1. In the variety tests from 1914 to 1920 inclusive, this was the earliest and highest producing variety out of about 40 tested. It soon became popular in some sections of the State where cotton wilt was not a serious factor, and because of its earliness was also a favorite for a while in a few sections in Georgia after the boll weevil became serious.

From 1915 to the present, the Georgia College of Agriculture has maintained the variety by continuous selection. Since Rast left the institution about 1918, R. R. Childs has handled the breeding and improvement work with College No. 1. In 1926 the selfing of strains was begun and carried through 1933. This work led to a variety much more uniform in staple length, which at present averages 1 to $1\frac{1}{16}$ inches.

South Carolina

Probably the first cotton-breeding work done at the South Carolina Agricultural Experiment Station was started and carried on by J. S. Newman, who, while inspecting the progeny of an Allen Long Staple × Dickson cross, found an unusual plant which he marked by a blue band off a cigar. The selection was made about 1900 and the stocks, including several other cotton hybrids, had been sent to the station a few years previously by P. H. Mell of the Alabama Station. Newman, formerly from the Alabama institution, had been having these grown under his own observation.

The plant marked by the cigar band was picked separately, the seed was multiplied, and the stock was remembered as the Blue Ribbon variety. Out of some of the early progeny of the original Blue Ribbon plants a black-seeded variation was selected and developed into a second variety known as Black-Seeded Blue Ribbon.

The Blue Ribbon variety was a semicluster long-staple type, the cluster tendency coming from the Dickson parent and the long staple from the other parent—rather a distinct combination for a long-staple variety. The plants were medium to tall, abundantly fruited, compact, erect, with short joints, medium to early in maturity; bolls small, lint percentage 32 to 33, staple $1\frac{1}{8}$ to $1\frac{1}{4}$ inches.

Additional breeding work was carried on by C. L. Newman, the son of J. S. Newman, at the South Carolina Station a few years later. During the summer of 1906 C. L. Newman made a number of new crosses among some of the better upland varieties. In the winter of 1906–7 a larger number of standard varieties were collected, and these were tested in 1907 to determine their suitability for hybridization and also for line selecting. Crosses were made, usually between a short-staple and a long-staple variety, and from 300 of these C. L. Newman, J. N. Harper, and Burns Gillison selected 20 of the better appearing progeny rows in 1908. Several new strains or varieties were developed during the next few years from this hybrid work and from some of the older hybrids.

Out of the line selections, new strains of Wanamaker Cleveland, Toole, and Russell were derived. Tillman Pride came from a single plant selection out of Black-Seeded Blue Ribbon.

In 1911, H. W. Barre of the South Carolina Station, and his assistant, L. O. Watson, began cooperating with Orton and Gilbert of the Bureau of Plant Industry in breeding wilt-resistant varieties. Through the Pee Dee Branch Station at Florence and farmer cooperators, further improvement and distribution of the Dixie, Dixie-Triumph, and other wilt-resistant varieties were carried on. After Watson replaced Gilbert in the work in 1914, C. A. McLendon held Watson's position at the South Carolina Station from 1914 to 1916. After McLendon resigned in 1916 and Watson in 1920, breeding work was discontinued. It was realized that the several commercial breeders in the State were providing farmers with reliable and ample supplies of planting seed of all of the more suitable varieties, and the station therefore directed its efforts to solving other cotton problems. Since his resignation L. O. Watson has been a commercial breeder at Florence.

Tennessee

Cotton-breeding work at the Tennessee Agricultural Experiment Station in cooperation with the United States Department of Agriculture was begun soon after 1900 by S. M. Bain. An account of Bain's work has already been given.

Stocks of Trice, which was the variety Bain developed, were maintained under his supervision for many years by farmers who would observe the necessary precautions to keep the seed pure. After Bain discontinued his work, J. F. Bridger, of Bells, Tenn., preserved, grew, and distributed the variety until a few years ago.

Recently Newman I. Hancock and the late S. H. Essary of the Tennessee Station began some further work in breeding the Trice variety to preserve this stock and also to restore it to former uniformity and further improve its economic value. They developed Trice 5, Trice 25, Trice 5–42, and Trice 25–1–45. These men have also done some selection work with both the Acala 5 and the Acala 8 types. Acala has also been used recently in hybridization with the Stoneville type. One hybrid strain from a 1930 cross between Stoneville 2 and California Acala is in the process of development.

Texas

Heavy boll weevil damage in Texas before the spread of the insect to other cotton States made this State the first to start control measures. In addition to other remedies applied, the importation and

acclimatization of foreign kinds, and the introduction of varieties from other parts of the Cotton Belt were tried. Considerable work in varietal adaptation was undertaken by the Texas Agricultural Experiment Station. Beginning soon after 1900, R. L. Bennett of the Texas Station worked for several years with the variety problem in cooperation with the United States Department of Agriculture. All the well-known varieties from the earliest to medium early were brought in from the other cotton States and tried, along with those native to Texas.

During this period seed of small-boll short-staple varieties such as King, Sugar Loaf, and Simpkins were being imported annually in thousands of carloads to Texas, but they were very unsatisfactory to the cotton growers and buyers of the State. Bennett and other workers formulated ideas as to the best cotton to breed to meet the problem. The specification decided on was a short-jointed, big-boll, stormproof, medium-staple, early type with high lint percentage. This ideal served as a model for Bennett while he was at the station and also for the other cotton breeders who were working in Texas at that period.

While with the Texas Station Bennett began to select for more earliness from among the native Texas varieties. His first important selection was made in 1904 from Mebane Triumph. After 1908 this stock was planted as a new variety, referred to as the Bennett Selection. As a result of Bennett's work and that of the Department of Agriculture, and private interests, importation and cultivation of small-boll short-staple cotton in Texas was discontinued.

Shortly after Bennett left the Texas Station, H. H. Jobson took up the breeding work from 1911 to 1916 and emphasized inheritance studies with the object of obtaining information fundamental to breeding for practical ends. However, some of the branch-station superintendents continued the selection work for improvement alone. In 1916 E. P. Humbert continued Jobson's inheritance studies, and between 1916 and 1921 began the program of State certification and registration of cotton varieties. George F. Freeman, who was with the Texas Station in 1921 and 1922, also continued the inheritance studies and initiated plant-to-row breeding at the main station and several substations. This resulted in the development of a few new varieties or strains.

G. N. Stroman worked with the station from 1923 to 1925 but confined his attention mostly to a continuation of inheritance work, biometrical studies of certain characters in cotton varieties, and general variety testing. During this time the substation superintendents continued plant-to-row work.

Since 1925, D. T. Killough, formerly superintendent of substation no. 5 at Temple and later of the main station farm at College Station, has been in charge of cotton breeding and improvement for the experiment station. He has worked with several of the substation superintendents in developing varieties and strains by plant selection and by hybridization.[11]

[11] These varieties include: Belton 793; developed from Rowden; originated 1912 by A. K. Short while superintendent of substation no. 5, Temple. Belton 5984; improved strain also developed from Rowden; introduced 1920 by D. T. Killough, who at that time had succeeded Short; grown extensively for a period in communities in central Texas. Westex 8487; developed from Burnett by R. E. Karper, 1921. Mebane 804-14 and 804-53; developed from Mebane Triumph by R. E. Dickson. Startex 619; developed at College Station from Lone Star by D. T. Killough and G. T. McNess, 1927. Mebane 4120-140, 4120-141, 4120-153; developed from Mebane Triumph by J. R. Quinby, 1925. Mebane 804-50; developed from Mebane Triumph by D. T. Killough and R. A. Hall, 1927. Mebane 804-29 and 804-36; developed from Mebane Triumph; introduced 1927. Ducona; hybrid from Durango × Wacona; developed by D. T. Killough and D. L. Jones, 1927. Sunshine 10104-137-5 and 10104-114-3; developed from Sunshine by D. T. Killough and P. B. Dunkel, beginning in 1929.

D. T. Killough, W. R. Horlacher, and graduate students have done considerable work in cotton genetics during the last decade. They have worked on a number of plant characters and have also studied mutations induced by X-ray treatment.

Florida

About 1909–10 at the Florida Agricultural Experiment Station some work was done in the improvement of the Seabrook strain of sea island. New strains were developed by plant selection and distributed among sea island cotton growers of the State. In 1924 some hybrid work was started at the Florida Station. Many crosses were made between Council-Toole and Lightning Express, strain 3 and strain 4, with the object of obtaining an early wilt-resistant variety with improved staple.

In 1926, W. A. Carver planted F_2 or second-generation selections of the former set of crosses in a plant-to-row test and made some new selections from Carolina Foster and Cook 307–6. Hybrid strains were developed which possessed resistance to wilt and boll rot, were earlier and had a longer staple than the Council-Toole parent, and had a larger boll and a higher lint percentage than Lightning Express. Carver also continued progenies from selections from the three parental stocks entering the crosses and published some genetic studies of several characters in the upland species.

Breeding work at the Florida Station was discontinued in 1933 before the hybrid strains were ready for introduction. The two Toole strains have been introduced to farmers and grown to some extent in one of the counties.

Mississippi

Cotton breeding work was begun at the Mississippi Agricultural Experiment Station in 1911, when E. C. Ewing resigned from the Department of Agriculture and began work with the station. Ewing's first accomplishment at the station was the introduction and establishment of the Express variety, bred by D. N. Shoemaker in the Department of Agriculture. While an employee of the Department, Ewing had had an opportunity to observe the new variety where it was being tried in Texas in 1909 and 1910. It was not suitable for that State and was about to be discarded. It had occurred to Ewing, however, that Express would be splendid basic material for breeding a new type of long-staple cotton more suitable for boll weevil conditions in the Mississippi Valley than were the old late varieties. When he introduced it later, it became very popular and soon spread over the Delta and bottom lands of Mississippi and also extended into much of the alluvial lands of other Mississippi Valley States.

During the period of multiplication and spread of the original Express stocks, Ewing selected and developed new strains of the variety. The old stock had some objectionable features such as slender and long-jointed plants, low lint percentage, and some mixture of off types. The two best new strains selected were Express 350 [12]

[12] Express 350 was developed from a single plant selection made in 1913 and differed from the original stock in being a shorter, more compact, more uniform, and more prolific plant type. The staple length was about 1 3/16 inches and the lint percentage 28. Express 432 originated from a single plant selection made in 1914 and differed from the original stock in having a larger and more spreading plant; higher lint percentage, 31 to 33; shorter staple, about 1 1/8 inches; and more wilt resistance.

and Express 432. These have provided foundation stock for practically all later breeding with the Express type.[13]

In 1911 Ewing also obtained a sufficient quantity of the new Foster variety of cotton from the Department of Agriculture to plant a small field at the Delta Branch Station. Out of this field he made plant selections, and during the next few years two strains, Foster 11 and Foster 120, were developed from two plants taken in the 1911 season. The latter was a high-yielding strain and was distributed to growers. The former was discarded.

Selection work was started by Ewing with Lone Star in 1911, with Trice in 1913, and with Wannamaker-Cleveland some time during the latter part of the 1911–15 period. From the original selections of

FIGURE 22.—Cotton-picking scene in a field of Express cotton, taken in 1922 at Clover Hill, Miss., in the Yazoo Mississippi Delta.

Lone Star three strains, Lone Star 11, Lone Star 15, and Lone Star 132, were developed. One of the 1913 plants of Trice was the parent of what later became Mississippi Station Trice.

In 1915 Ewing began cotton-breeding work with the Delta & Pine Land Co. of Mississippi at Scott, Miss., and H. B. Brown succeeded him in the Mississippi Station work. On taking over the station work, Brown continued the cotton-breeding program of his predecessor. He completed the breeding work with the Express 350 and Express 432 strains and distributed the stock (fig. 22). He also continued to work with the Foster, Lone Star, Trice, and Wannamaker-Cleveland stock with which Ewing had begun to select breeding lines.

In 1916 Brown began selection work in a field of Foster 120 which resulted in the development of Foster 6102 and Foster 631. These

[13] The several Lightning Express strains, the Burdette Express, and Dortch Express came from Express 350. Express 121, Delpress 3, and Arkansas 17 came from Express 432. These Express strains and some of their derivatives have also been used extensively in hybridization with other varieties. Two other strains of this type, Express 15 and Express 122, selected by Ewing during the earlier years of his tenure with the Mississippi Station, have been important as parental material in the breeding of Salshury and the Delta & Pine Land varieties. Express 15 was one of the parents of Salsbury and Express 122, a parental line from which Delta & Pine Land 3 is descended. Delta & Pine Land 3 was one of the parents of Delta & Pine Land 10, and Delta & Pine Land 10 one parent of Delta & Pine Land 11. Express 15 and Express 122 although of much value as parental material in hybrids, were never commercially important themselves.

were named Delfos (from Delta and Foster).[14] Each of the two Delfos types was superior to Express in several respects—They were more easily picked than Express and were higher in lint percentage than the Express 350 type. The Delfos 6102 type was the more popular. By 1925 the Delfos types had practically replaced the Express 350 type and also much of the acreage formerly in the Express 432 type. In most cases Delfos cotton has supplanted all other long-staple varieties in the Mississippi Valley and has been a strong competitor with this group of varieties in other sections of the Cotton Belt.[15]

In 1922 H. B. Brown became plant breeder for and partner in the Stoneville Pedigreed Seed Co. of Stoneville, Miss. After 1923 H. A. York became assistant to W. E. Ayres. Ayres, who had come to the branch station and taken over the long-staple breeding work in Mississippi at the Delta Branch Station at Stoneville in 1920, continued the development of the Delfos strains. York, however, has had the responsibility of this work himself since 1926. Certain strains of the Delfos 6102 type have been continued by the Stoneville Pedigreed Seed Co. and several other seed-breeding or growing firms. Both the Delfos 6102 and the Delfos 631 types have been used as breeding lines by H. B. Brown since he went with the Louisiana Agricultural Experiment Station in 1926.

In 1915 Brown selected plants out of the Station's Wannamaker-Cleveland stocks and developed from one of the original selections the Cleveland 54 strain, introduced several years later. From one plant of Lone Star 15, thought by Brown to be a hybrid stalk with Mississippi Station Trice and selected in 1916, he developed the Lone Star 65 strain, which was the parent of the Stoneville cottons later developed by Brown and others for the Stoneville Pedigreed Seed Co. In 1920 Brown selected plants from the Rowden stocks which he was carrying at the station, and one of these developed into the Station Miller variety. In 1921, Ayres, at the Delta station, selected plants out of Express 432 which resulted in the development of the Express strain 121.

J. Fred O'Kelly succeeded Brown at the Mississippi Station in 1922. He completed the development of the Station Miller variety, and from this in turn developed Miller 610. In 1930 a cross between a Miller strain and a Delfos was made, but the new hybrid variety has not been distributed as yet.

York, in addition to the work with Delfos and Missdel, has continued work with Express 121. In 1926 he isolated Delpress 3, named for Delta and Express.

The Delfos cottons have been the most important contribution in the cotton-breeding work done by the Mississippi Station. The strains produced by the Delta Branch Station are now designated as Missdel, from Mississippi and Delta.[16]

[14]The plants of the 6102 type were smaller and more dwarf than were the plants of the Delfos 631 type. The former type was also more extreme in earliness than the latter. Delfos 6102 had a staple length of 1 3/32 to 1 5/32 inches, lint percentage 31 to 32, rather small bolls. Delfos 631 had a staple length of 1 3/16 to 1 1/4 inches, lint percentage 30 to 31.5, bolls intermediate in size and more storm-resistant than those of Delfos 6102.

[15]Later Delfos selections were: Delfos 910, out of Delfos 631 (1919); Delfos 911, out of Delfos 6102 (1919); Delfos 0556, out of Delfos 6102 (1920); Missdel 2, out of Delfos 6102 (1931) and Missdel 1 out of Delfos 631 (1922); Missdel 3, out of Delfos, 910 (1923).

[16]The Missdel strains with odd numbers originated from the Delfos 631 type and those with even numbers from the Delfos 6102 type. Strains of Missdel so far developed are Missdel 1 and Missdel 1 Wilt Resistant (Delfos 631 type); Missdel 2 (Delfos 6102 type); Missdel 3 (Delfos 631 type); Missdel 4 (Delfos 6102 type); and Missdel 5 (Delfos 631 type). Recently the cotton varietal standardization committee of the Association of Agricultural Workers and the committee with the same title of the American Society of Agronomy have decided that the strains belonging to the Delfos 6102 type should retain the type designation of Delfos and that the strains belonging to the Delfos 631 type should be known as Missdel.

Arkansas

About 1912 cotton-breeding work was begun at the Arkansas Agricultural Experiment Station by W. C. Lassetter and M. S. Baker. The early efforts were concerned with line studies of Allen Long Staple and Cleveland, and with crosses between these varieties. Some straight selection for improvement was also carried on with Trice, Cleveland, and a few other varieties. Trice selection studies were emphasized especially.

In 1915 Lassetter transferred to the extension service in the State, Baker resigned, and W. E. Ayres was appointed to do the cotton work for the station in 1916. In 1917 Ayres, in addition to the experiments that had been carried previously, began new work dealing with selections of Foster 120 for high and low oil and protein; Mebane Triumph for size of boll, length of staple, and lint percentage; and Express 432 for wilt resistance. Ayres was connected with the Arkansas Station until 1919, when E. A. Hodson took up the work and carried it until July 1920. During his tenure, Hodson published reports on the Trice studies and on some other phases of the cotton studies. J. O. Ware succeeded Hodson and continued with the station to 1935. Most of the studies inaugurated and developed by Lassetter, Baker, and Ayres were continued during the period of Hodson's and of Ware's tenure.

In 1921, selection work was started with Rowden, Acala, Meade, Lone Star, and additional strains of Express. Further investigations in cotton inheritance and in the genetics of the plant were also inaugurated. By 1923 and 1924 several new strains were isolated from lines of breeding material of the older work that had been carried by the station. These were Triumph 154, an early strain from the Mebane Triumph lines; Trice 323 from the old Trice lines; and Foster 140 from the Foster 120 oil and protein study lines.

During 1925, 1926, and 1927, new strains of the Rowden, Express, and Acala were isolated from the additional selection work started in 1921. These were Arkansas Rowden 40, Arkansas 17 (Express), and Arkansas Acala 37.[17] These varieties have become very popular in Arkansas, especially the Arkansas Rowden 40. This new variety has also spread to surrounding States to a considerable extent. Arkansas Rowden 40 is earlier and more uniform than the old parental Rowden variety, which was obtained from Rowden Bros., Wills Point, Tex. It has high quality, staple 1 to 1 1/16 inches, big bolls, storm resistance, hardiness to drought, and considerable wilt resistance, and it produces high yields.

Since the three Arkansas Station varieties were introduced, a number of newer strains of Rowden and Acala have been developed by the station. Arkansas Rowden 2088, a strain selected out of Arkansas Rowden 40, and other newer Rowden strains are rapidly replacing this parental variety because it has somewhat deteriorated

[17] Assistance was rendered by R. L. Dortch in helping to develop and distribute Arkansas Rowden 40, by Earl Kilpatrick in distributing Arkansas Acala 37 and other station strains, and by others who have multiplied station stocks. Arkansas 17 is a wilt-resistant variety, excellent for bottoms and the richer uplands—a staple 1 1/8 to 1 3/16 inches, bolls larger than the old Express strains. The new variety is thought to have come from the Express 432 type, the stock of which had been obtained from the Delta Branch Station, Stoneville, Miss.; it resembles these stocks more than other lines from which selections were made. Arkansas Acala 37 is not wilt-resistant, but does well on both bottom land and upland where wilt is not a serious factor. It is more especially adapted to the northern parts of the Cotton Belt because of its earliness. The selections from which this new variety came were taken from a plot of Acala No. 5, the seed of which came from C. N. Nunn.

through segregation or mechanical mixture. Later strains are also replacing Arkansas Acala 37.[18]

The improvement work at the Arkansas Station was all done by the progeny-row method and a large number of later line-selected strains of Rowden, Acala, and Lone Star are undergoing strain tests at present. The line-selected stocks begun in 1921 were temporarily discontinued and stored in 1933.

The new varieties and strains developed by the Arkansas Station have reached the farmers through stocks grown by the Cotton Branch Station in Lee County near Marianna, and by several large seed growers. The extension service of the State was instrumental in popularizing the product of the station's breeding program among the farmers. As a result of this the quality of the crop in the State has been much improved in the last 7 years.

In addition to the breeding and improvement work at the Arkansas Station since 1920, several papers on the genetics of cotton have been published from material developed in the research program.

O. A. Pope joined the Arkansas Station staff in 1930 and has specialized in the study of cotton fiber with special reference to the breeding program. Several papers pertaining to this study have been published recently. L. M. Humphrey is at present in charge of the cotton genetics and breeding work at this station. Pope resigned in December 1935.

North Carolina

In 1914, when R. Y. Winters began cotton breeding and improvement work at the North Carolina Agricultural Experiment Station, he obtained two types of cotton, one a large-boll type, medium in time of maturing, and the other a small-boll early type. The former was Hope Mexican Big Boll, obtained from J. D. Hope of Sharon, S. C. In addition to having large bolls and medium maturity, this variety ranked high in yield, was easy to pick, had short staple of good quality, lint percentage around 35, and large, fuzzy seeds gray to brown in color. The small-boll early type was King, a variety grown extensively at that time in North Carolina.

Selfed lines from both types were developed and continued for a number of years and meanwhile a study of their relative stability through several generations was made. A few of the King strains were multiplied and distributed to some extent, but none turned out to be as satisfactory as the Mexican strains. Two of these, Mexican 6 and Mexican 18, were introduced to growers in 1920.[19] They have been widely grown in North Carolina. More recently selected strains are being developed to replace the older ones in case they should prove to be better or in case the older strains should begin to show deterioration. Mexican 87 has been developed from Mexican 18 and Mexican 128, and Mexican 58–14 from Mexican 6.

P. H. Kime, V. R. Herman, and S. W. Hill assisted Winters in the breeding program, and since 1925, when Winters became director of the station, Kime has had charge of the breeding and improvement work.

[18] The later strains of Rowden are Arkansas Rowden 4046, Arkansas Rowden 5056, etc. The newer strains of Acala are Arkansas Acala 34, Arkansas Acala 4067, Arkansas Acala 5119, Arkansas Acala 1114, and Arkansas Acala 891.

[19] These strains had been developed each from single plants by the plant-to-row and progeny test methods. They were similar in general appearance—medium-sized plants, early and prolific for a big-boll type, moderate-size leaves, staple 1 to 1 1/16 inches and of good quality, lint percentage 34 to 35.

Between 1916 and 1921, Winters, Kime, Herman, and Hill also carried on breeding work with the Cleveland variety. Several strains were developed from Wannamaker-Cleveland, and the more promising of these were turned over to the Edgecombe Seed Breeders Association at Tarboro, N. C. Through the assistance of Herman and later of Hill, both then employed as commercial breeders, these strains were preserved, multiplied, and sold to farmers from about 1921 to 1926.

Yield-test data from 111 tests conducted by the North Carolina Station for 17 years during the period 1915 to 1933 show the value of a breeding and improvement program to the variety situation in a State. In the tests, the acre yield of lint for the Mexican (station-bred) variety averaged 475.2 pounds as compared with 440.3 pounds for the unimproved varieties in use by farmers in the sections of the State where the tests were conducted. The acre value of the lint of the Mexican variety over this period was $121.24 and that of the unimproved varieties $106.11.

Spinning tests were also conducted for several years in order to compare station-bred strains with several other standard cottons. In one series of tests, the Mexican Strain 6 was compared with Acala 5 and 8, Lone Star, Rowden, Trice, Sugar Loaf, Cleveland, and a typical north-Georgia cotton. The fiber was spun into no. 28 yarn and broken. The yarn from the Mexican 6 strain proved to be stronger than that of any of the other varieties tested. In another breaking test, with no. 30 yarn spun from two crops in 1932 and 1934, Mexican 6–128 (station-bred) proved to be stronger than the other varieties, Acala, Coker-Cleveland 884–4, Farm Relief 1, and an Arkansas Rowden strain.

Oklahoma

The Oklahoma Agricultural Experiment Station began some plant selection and progeny row testing in 1914. A very early and well-adapted variety was much needed in Oklahoma at that time to cope with the boll-weevil problem. In the first year of the undertaking, a plant of early type was found by Glen Briggs in a field of the Mebane Triumph variety near Stillwater, Okla. Briggs was a senior student in the Agricultural and Mechanical College when he selected the parent plant. Doubtless this original plant was a natural hybrid with some local early variety that had previously grown near the Mebane Triumph parent material. From this, M. A. Beeson and Briggs developed a very early new variety designated as Oklahoma Triumph 44.

The variety has shown very desirable adaptability to Oklahoma conditions, both in the badly infested weevil areas of the southeastern part of the State and in the general area of the State toward the northern rim of the Cotton Belt. It has been widely grown, and for 6 or more years has occupied 300,000 to 400,000 acres in the State. A considerable portion of the stock used has not always been as pure as would be desirable because of the usual methods of handling seed stocks in such cases. On the other hand, several seed growers in the State have assisted in maintaining and distributing pure seed stocks, and some one-variety-community work has helped to keep it pure.[20]

[20] Since the introduction of Oklahoma Triumph 44, other strains, designated as Early Triumph, have been selected and propagated from this variety. Early Triumph 29 was introduced in 1923 and Early Triumph 32 in 1924. These newer strains were bred for more uniformity, especially in fiber.

From 1921 to 1926 Glen Briggs was in charge of the cotton breeding and improvement work at the station, and since the latter date L. L. Ligon has been in charge.

Some breeding work has also been carried on with selections from the Acala 5 type. A new strain of Acala 5, somewhat earlier than the parental material and designated as Acala 44, was developed in 1924. Some selections from the Acala 8 type and Arkansas Rowden 40 have also been made. The work with the former was begun in 1932 and with the latter in 1934. However, sufficient time has not elapsed as yet in the case of these last two cottons to obtain new varieties for distribution.

New Mexico

In 1923 a strain of Acala was introduced to farmers by the New Mexico Agricultural Experiment Station. Bred in California by the United States Department of Agriculture, the stock came from the

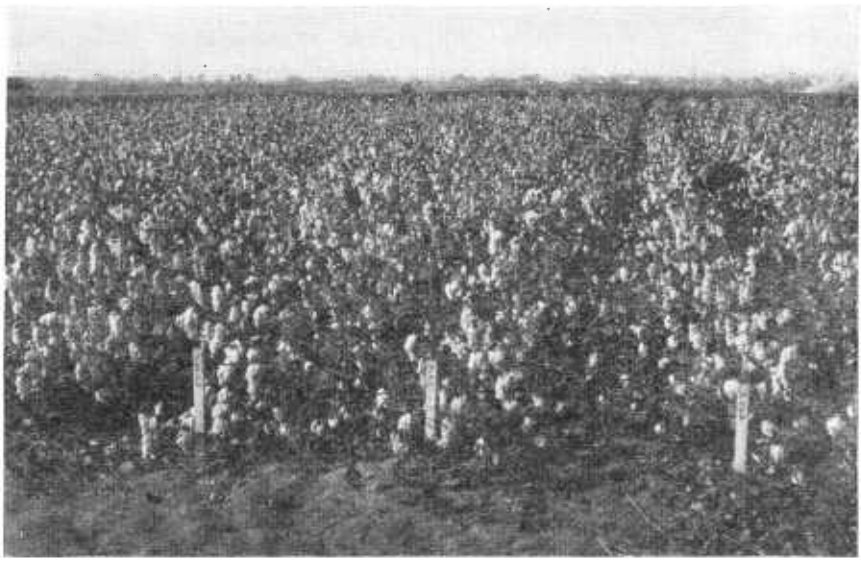

FIGURE 23.—Breeding block of Acala cotton, State College, N. Mex.

Acala 8 type and was designated as College Acala. In New Mexico the variety steadily increased, and in 1932 it occupied about 85,000 acres. It is still popular and continues to replace other varieties and strains of Acala. Since 1926, when the United States Acclimatization Field Station was established in the State, this station has cooperated with the New Mexico Station in maintaining seed stock of the variety for farmers.

In the fall of 1928 the New Mexico Station started an extensive project in cotton breeding, under the leadership of G. N. Stroman. The initial selections were made from College Acala and other stocks of the 5 and 8 types. Selections from other varieties were also made but were dropped after preliminary testing. Subsequently each year a few additional selections were made from some large fields of Acala in order to bring in new stocks that might have promise of superior performance (fig. 23).

The work has centered on a study of the breeding lines rather than an effort to hastily produce new strains for distribution. Pollination has been controlled from year to year in order to maintain the purity of the stocks. The progeny lines have been sorted on the basis of a comprehensive study of all the important economic characters involved, including seedling vigor, general plant type, earliness, yield, boll weight, percentage of lint, lint index, length of lint, and other fiber characters such as convolutions, diameter, and arrays.

Certain families in this series of Acala selections, particularly one designated as Family 504, have been isolated as having particular merit in possessing a large number of the desirable characteristics. The Pressley fiber sorter has been used to good advantage in isolating breeding lines at the New Mexico Station.

Louisiana

Systematic work in cotton breeding and improvement was not carried on to any appreciable extent in Louisiana until H. B. Brown joined the staff of the Louisiana Agricultural Experiment Station in 1926. In 1927 Brown started variety test work in representative sections of the State. He brought stocks of the breeding lines he had originated and continued while at the Mississippi Station and with the Stoneville Pedigreed Seed Co.—Delfos, Express, and Stoneville. Dixie-Triumph, obtained from L. O. Watson of Florence, S. C., and some of the Delta & Pine Land strains originated by E. C. Ewing of the Delta & Pine Land Co. of Scott, Miss., were also used as foundation stock by Brown. Since the same stocks were utilized, Brown's output has naturally blended with the introductions of the Mississippi agencies. In his regional variety tests, he found the strains of the Delfos, Stoneville, Express 432, Delta & Pine Land, and Dixie-Triumph types to be the lines of most promise for further breeding work in Louisiana.

Delta & Pine Land 4–8 was especially suited to the poor hill lands of northern Louisiana, where a vigorous, "rough-and-tumble" variety is needed to withstand the cultural hardships of the section. Its high lint percentage and hardiness probably came from the Mebane Triumph parent. Delta & Pine Land 10 was more prolific than Delta & Pine Land 4–8 and better suited to richer land, where it produced more than the older strain. The earliness and prolificness of Delta & Pine Land 10 are inherited from Express. The Express and Delfos types, especially the Delfos 6102, have been adapted more especially to bottom and other richer lands. The Dixie-Triumph variety was suited for areas infested with cotton wilt and it seems to resist more effectively than the other varieties some other common diseases, such as anthracnose, angular leaf spot, and rootknot. This type has the wilt resistance of the Dixie and the substantial hardiness, boll size, and lint percentage of the Mebane Triumph ancestor. The Stoneville strains, especially nos. 2, 3, and 5, had rather wide adaptation in the State except on some of the poor coastal plains and hill lands, where Delta & Pine Land 4–8 did better.

Express for a long period has been a very suitable cotton for lowlands because of its earliness and tendency to fruit under conditions conducive to overdevelopment of vegetation in most other varieties. The Delfos strains, especially the 6102 type, are well known for earliness and prolificness. These tendencies are perhaps results of mutation, as the ancestry did not show the traits in such a pronounced way.

The Stoneville cottons have earliness and prolificness, inherited from their Trice ancestry. The Lone Star ancestry provided inheritance in the Stonevilles for boll size, fair staple length, and medium to high lint percentage.[21]

In carrying out the breeding program, numerous plant selections were made from material grown in representative regions. These were tested in progeny rows, and strains from the better rows were tested for 2 or more years thereafter. The selected strains were increased in isolated fields and tried out in the variety tests in representative areas. This procedure is repeated with newly selected material from year to year or when it is desirable to supply additional breeding lines.

Numerous crosses have been made almost every year since 1926 to combine desirable characters or eliminate unwanted traits. As yet, new strains from this work have not been fully developed, but promising material seems to be present in some of the hybrid lines being carried. The straight-line selection work, on the other hand, has brought forth a number of strains and several of these have been distributed to the farmers of the State.[22]

Progress has been made in the variety situation in Louisiana. The staple has become longer and more uniform in length, and production has increased in comparison with that of former varieties. This improvement is due not only to introductions made by Brown, but to the more recent breeding work at the Louisiana Station. In 1932, 11 tests were conducted in various parts of the State. The average production of station strains and varieties in these tests was 357.9 pounds of lint per acre. The average production of varieties from other sources was 335.0 pounds per acre. The average production of the best station strain, which outyielded all the varieties tested, was 403.2 pounds. The leader and two others of the five ranking varieties in the tests were station selections.

Arizona

In Arizona in 1934 about 136,000 acres were devoted to cotton and about 28,000 acres of this were planted to American-Egyptian, a type heretofore described as bred and developed by the United States Department of Agriculture. Of the remaining 108,000 acres, about 97,000 were in strains of the Acala 8 type, and 11,000 acres in the Stoneville and Mebane Triumph types. The seed stocks of Acala originated in California at the Shafter and Indio United States Field Stations, and have been obtained from California growers and brought into Arizona from time to time by several cotton and cottonseed agencies.

The breeding work at the United States Field Station at Sacaton has been concerned almost entirely with American-Egyptian, but

[21] The Express strain introduced by Brown was Express 317, developed from the Express 432 type. This line has more wilt resistance, a higher lint percentage, and a larger boll than the old Express 350 type. The Delfos 631 type, represented by Delfos 2; the Delfos 6102 type, represented by Delfos 2323; the Stoneville strains 1, 2, and 3; some breeding lines of Dixie-Triumph; and some stock of Delta & Pine Land 4-8 also have been included in Brown's breeding stock at the Louisiana Station.

[22] These include: Express 070; from Express 317; developed 1930; now being introduced. Dixie-Triumph 757 and 759 (1927) and Dixie Triumph 85 (1928); from Watson's Dixie-Triumph; now being introduced. Delta & Pine Land 829; from Delta & Pine Land 4-8; developed in 1928 for northern Louisiana and now being increased there. Stoneville 022, from Stoneville 2; Stoneville 3-03, from Stoneville 3; 1930; now being introduced. Delfos 978 and 969 (1929); Delfos 032 (1930) and 130 (1931); from Delfos 2323; now being introduced. The Delfos strains of Delfos 6102 ancestry all resemble the original type in earliness and prolificness, which were very marked characteristics of that variety. It possessed these qualities in a much greater degree than any of its known ancestors. Apparently a new line of merit originated here as a mutant. It held its type for about 10 years and then began to vary, and the exact type disappeared. In 1931 a strain was isolated that is very much like the original Delfos 6102 type in characteristics. This is Delfos 2323-130 noted above.

some work has been done with Acala. However, no stocks of Acala have been generally distributed from this station. The Arizona Agricultural Experiment Station has done some work with the Acala 8 type, but none of the stocks has gone to farmers as yet. Through selection and progeny isolation, E. H. Pressley has a strain of Acala about ready for distribution. He also has a strain each of Stoneville and Mebane Triumph at about the same stage of development.[23]

Bryan about 1927 isolated a red-leaf strain of upland cotton which he developed from seed obtained from a farmer. The lint of this strain was very uniform, but the number of motes or undeveloped seeds was so great that it could not be used commercially. Bryan is also studying a cross between Pima and Tanguis (Peruvian) cottons. Fourth-generation segregates were grown in 1935 and certain of these combine the length of the Pima fiber with lint percentage approaching the high percentage of Tanguis. There is some promise that an improved long-staple variety can be established from the best of these segregates.

A Challenge to the Superiority of American Cotton

SINCE records of cotton varieties and strains have been kept, over 1,200 names have been listed as growing in the United States. Many of these so-called varieties, however, have been synonyms or new names applied to the same stock by different growers. A large proportion of the varieties listed at any period soon vanish, as is indicated by surveys made at a later period. Tracy stated that of the 58 varieties named in the Tenth Census report for 1880, only 6 were commonly in cultivation in 1895. These were Boyd Prolific, Dickson, Bancroft Herlong, Peeler, Petit Gulf, and Texas Stormproof. None of these is grown at present and most of them are extinct. Of the 118 varieties listed by Tracy in 1895 only 2, King and Truitt, were present in 1925. Tyler listed over 600 varieties in 1907. In 1925 not more than 25 of this list were in existence and only 9 were cultivated extensively.

A very high percentage of the varieties, then, come and go within a rather brief period, but a few lines seem to be continuous. The history of the leading varieties of today dates back over a considerable period and doubtless this period would be much longer if earlier records had been kept. It is evident from the preceding history that practically all the present upland varieties and strains originated from a few that were notable at various periods in the past century. Sea island apparently dates back to 1785. American-Egyptian dates back to a small patch of imported Mit Afifi grown in 1900 on the spot where Calexico, Calif., now stands. The development of Egyptian cotton itself dates back to 1820.

One of the chief factors contributing to the success of the upland cotton industry has been the absence of foreign competition. This

[23] The Acala strain has staple 1⅛ inches in length, lint percentage around 37, bolls about 60 to the pound. The Stoneville strain has staple 1$\frac{1}{32}$ inches, lint percentage about 35, bolls about 60 to the pound. The Mebane Triumph strain has staple 1$\frac{1}{16}$ inches, lint percentage about 39, bolls about 51 to the pound; this strain is characterized by very large bolls and high yields.

has now entered the picture in an intensified form. The trend of foreign cotton acreage and production for the past 45 years has been upward, but this increase abroad did not reach serious competitive proportions until after the World War, when the improved quality of much of the cotton grown outside the United States brought it into direct competition with American upland. The increasing volume of this better cotton abroad has been a result of various economic causes, but the actual establishment of the types has been made possible by the importation of American sorts, breeding them for climatic adjustment, and breeding and improving native kinds as well. The discussion of cotton breeding in foreign countries which follows describes this effort. World cotton production for the 10-year period 1924–25 through 1933–34 is shown in table 1.

TABLE 1.—*World production of cotton*

[10-year average, 1924–25 to 1933–34]

Country	Production, 1,000 bales of 478 pounds	Percentage of world production	Country	Production, 1,000 bales of 478 pounds	Percentage of world production
United States	14,704.6	55.92	Uganda	162.6	0.62
India	4,448.0	16.92	Chosen	133.7	.51
China	2,150.1	8.18	Argentina	130.1	.50
Egypt	1,522.7	5.85	Anglo-Egyptian Sudan	123.8	.47
Union of Soviet Socialist Republics	1,274.9	4.85	Other foreign countries	549.4	2.09
Brazil	590.8	2.25	All countries other than United States	[1] 11,591.9	[1] 44.08
Peru	246.7	.94			
Mexico	220.9	.84	Total world production	26,296.5	100.00

[1] Computed from the figures in the table. Actual reported production was 11,569,700 bales, and actual percentage of world production, 44.00.

The most effective way to meet this competition is to sort out our own best lines, further breed and purify them, substitute these few good varieties for the many indifferent ones now used, and grow them according to environmental requirements through cooperation among the growers. The best American lines have been pointed out in what has already been said, many good examples of breeding have been cited, and the success of the one-variety-community plan has been shown.

In addition to the one-variety-community effort, there has been a step forward in the standardization of varieties. A committee of plant breeders and agronomists of the Association of Agricultural Workers, affiliated with the American Society of Agronomy, have chosen 31 typical varieties of the Cotton Belt as standard. Many of these varieties are represented by several strains. The list with the varietal description is published by H. B. Brown in the Journal of the American Society of Agronomy (vol. 28, no. 1, pp. 69–79, Jan., 1936). The list of varieties is as follows:

Acala–5
Acala–8
New Boykin
Cleveland–5
Cleveland–884
Piedmont Cleveland
Wannamaker Cleveland
Cook 307–6
Delfos
Delta & Pine Land–8
Delta & Pine Land–10
Deltatype Webber
Dixie-Triumph
Dixie–14
Express–121
Lightning Express
Half and Half
Kasch
Lone Star
Mebane
Missdel
Station Miller
Mexican Big Boll
Oklahoma Triumph–44
Pima
Rowden
Arkansas Rowden–40
Toole
Stoneville
Trice
Wilds

The Development of Cotton Breeding in Foreign Countries

THE period of cotton culture in the area of what is now the southern United States is only a brief span in history in comparison with the total age of cotton husbandry. Cotton improvement in the modern sense may not be much older in the countries where the plant is indigenous than it is in the American Cotton Belt. However, some crude form of seed sorting or selecting may have materially accelerated the adaptation of wild forms to domestication in the regions where the cotton plant was native; and later, man perhaps continued in a more systematic way to select the local stocks that best served his purpose.

After communication developed between the early cotton-growing centers, there was probably an exchange of material, and the plant also spread to new centers of civilization where it had not been known before. The exotic thus mingled with the indigenous, and unless the types were too remotely related and incompatible, crossing occurred and additional kinds evolved. Those carried to new situations also expressed new characters, stimulated or permitted to appear by the change in environment. In these ways, there must have been much sorting of the more adaptable kinds.

So much progress had been made in the evolution of the cultivated forms at the time when the first reliable records and plant descriptions were made that no relationship can be established with the present wild forms, nor can the prototypes of the current races be definitely surmised. Apparently cotton is indigenous only to certain tropical countries, where it is a perennial. On introduction to temperate climates, where overwintering was prevented by frosts, adjustment to the annual habit must have been partly effected by man through picking out the more suitable forms for propagation.

India is the oldest cotton-growing country in the Old World of which there is historical record. If the plant is not indigenous, cotton culture spread there at a very early period from Indochina and has persisted to the present time.

In Egypt cotton culture is comparatively a modern development and the crop has been made up of exotic kinds. Doubtless cotton first spread to Egypt from India several hundred years ago by way of the Indian Ocean and the Red Sea, or overland by caravans, or from Arabia, Iran (Persia), or some other near-eastern country where it had been previously brought from a point farther east. Such stocks were grown in lower Egypt in a small way until the nineteenth century. A fine quality of cotton had been grown in the upper regions of the Nile, particularly in Abyssinia, from time immemorial, and seed of this was brought to lower Egypt about 1820. Other modern cotton-growing countries in Africa, like the Anglo-Egyptian Sudan, Uganda, and many areas of less importance, may have had native cottons from the African center of origin, but their present industry is based on New World kinds.

Records indicate that the Chinese began to make extensive use of cotton fiber about 1300 A. D. The cotton grown belonged to the

Old World group and was probably introduced from India or Indochina at a period doubtless considerably antedating the fourteenth century. Previous to the fourteenth century cotton was used in China chiefly as an ornament.

The Union of Soviet Socialist Republics has developed into a modern cotton-producing country in recent years. Asiatic cotton was introduced into Turkestan, now part of the Union of Soviet Socialist Republics, many years ago, probably from Iran (Persia), where it had previously been introduced from India. However, the most rapid expansion in cotton culture in that country has occurred since the revolution and during the present political regime.

Chosen (Korea) and Manchuria have grown Asiatic cotton, introduced from other parts of China or India, for a long time, but only recently have they developed much of a commercial industry.

Cotton probably is indigenous to parts of Brazil, for European explorers found the Indians growing cotton there in the sixteenth century. This was doubtless in the tropical sections, where perennial cottons are still grown, and the region may have been part of the South American center of origin of cotton. However, the plant could have been carried there much earlier by roving Indian tribes from areas nearer the western part of the continent, which are more likely to have been the South American center of origin. Cotton was also found to be grown in Argentine by the first Spanish explorers, but doubtless it had been carried there at some previous time from the center of origin. Although the commercial crop of Peru and Mexico has always been small, these countries are probably situated in the two New World centers of origin.

COTTON BREEDING IN INDIA

For perhaps 4,000 years India took first rank among the cotton countries of the world. Throughout this period the crop was grown extensively and converted into sufficient quantities of cloth and various other fabrics to meet domestic needs and in addition to supply traders who carried Indian products to foreign countries.

Indian textile work was done, as much of it still is today, with hand-operated equipment, which is very crude and primitive. Doubtless much of the product consisted of coarsely fabricated cloths, cordage, strings, and other textile-like materials. However, the native artisans were able to weave muslins of such delicate texture that they have never been equaled in fineness, and the garments made from these cloths were sometimes referred to as "webs of woven wind."

The native cotton of India, so far as is known, has always been very short in staple length, often one-half inch and less. However, it is possible that some sort of fine or long-staple kinds of cotton were cultivated in that period but later became extinct. After the industrial revolution, the modern mill could not duplicate the fine work of the artisans of India with the short cotton. The advent of the machine stimulated the demand for cotton with more length and a more uniform quality in general. The factory interests turned to the United States for most of their raw materials—sea island cotton for the finest yarns, and upland for the general run of goods—until the cotton famine of the American Civil War, when they resorted to other countries temporarily. This situation again stimulated the cotton-

growing industry in India as well as in all countries where there was a possibility of expansion. The final result has been the marked increase in foreign production in recent years.

India now is second in production to the United States and produced during the 10-year period, 1924–25 to 1933–34, an average of 4,448,000 bales of 478 pounds, or 16.92 percent of the world crop. The trend has been distinctly upward for the past 35 years. Two things have made it possible for the manufacturer to utilize increasing quantities of Indian cotton: (1) The quality of the Indian crop has been improved by bringing in exotic kinds and by breeding, and (2) mill machinery has been adapted as much as possible to the utilization of a much higher percentage of the shorter fiber, which still represents a large percentage of the Indian cottons. The bulk of the Indian crop is estimated as still ranging from three-eights to seven-eights in length, but many of the short-staple varieties have undergone marked improvement through breeding during recent years. Some effort was made over a hundred years ago to improve the Indian cotton crop by bringing in exotic kinds, and the American upland cottons thus introduced have recently been used as breeding stocks. Other exotic types, including sea island and Egyptian, have not succeeded in India.

The Dharwar-American or Sawgined-Dharwar, which is grown in the Dharwar district located in the southern part of the Bombay Presidency of western India, dates back to 1819. At that time seed of American upland designated as New Orleans, a well-known commercial or trade type of that period, was imported and distributed near the town of Dharwar. Subsequently the East India Co. about 1840 made experimental trials in Dharwar and other districts of the Bombay Presidency with a number of foreign cottons, of which New Orleans, Georgias (upland), sea island, and Egyptian were the more important. The results of these trials indicated that the New Orleans type was the most suitable of the several kinds tested for the Dharwar area. It became very popular in the district, and about 1860 the plantings of the New Orleans cotton exceeded those of the native Kumpta cotton (*Gossypium herbaceum*).

The Punjab Province of northern India is at present the most important area in India for American upland. As early as 1825 seed stocks of both the New Orleans and Georgian trade types were carried to the Punjab from the Dharwar district. However, the droughts were too severe in certain years for the new kinds of cotton, and farmers continued to grow the indigenous or desi type, which was hardier. But fields of American cotton were grown here and there, and since crossing with the desi type did not occur, the American stock remained pure, perpetuated itself, and became more and more acclimated. This American stock became known as the narma (acclimated) cotton of the Punjab. Apparently the Georgian type persisted to a much greater extent than did the New Orleans type, probably because of the earlier maturity of the former.

An early effort was made to cultivate American upland cotton in what is now the United Provinces. The first undertakings were not successful, but further trials were started in 1870 at Cawnpore which terminated in the acclimatization of a variety known as Cawnpore-American. In the period immediately after the American Civil War a number of exotic cottons were brought in, including several types of American upland from other parts of India—such

types as Cambodia and a Georgian type, Buri. Since 1900 a number of upland varieties from the United States, some of which were highly productive, have been imported by the cotton workers of India, but none has succeeded without some years of acclimatization and reselection.

Experiments with exotic cottons in the Sind date from 1846, when Egyptian seed was tried at Shikarpur and sea island at Rohri. These trials were unsuccessful. From 1852 to 1854 sea island and New Orleans (upland) were again tried under the direction of an American planter without success. From 1868 to 1888 experiments with introductions were carried on near Hyderabad and Karachi which were rather inconclusive. These trials were both with American and Indian varieties.

Improvement in Modern Indian Cottons

The very short staple cottons of India, many of them one-half inch and less, and all less than seven-eighths inch, belong to the *Gossypium neglectum* and *G. arboreum* native species, and are cultivated in Central India, Central Provinces, Berar, Bengal, and Assam. This cotton is suitable for spinning counts from 1 to 16 and amounts to a little more than 3,000,000 bales, or about 70 percent of the total crop of the country. The medium-staple cottons from seven-eighths to 1 inch belong to three species principally—*G. herbaceum*, *G. indicum*, and *G. hirsutum*. The first two are native species and the last American upland. The medium-staple cottons are cultivated in Bombay, Madras, the Punjab, and Hyderabad. This cotton is suitable for spinning counts up to 22. The growth of the American upland stock is chiefly in Bombay and the Punjab. The medium staple amounts to somewhat over 1,000,000 bales, or practically 30 percent of the crop.[24]

Most of the breeding and improvement work in India has been done in the Provinces and districts, where the medium staples have been chiefly grown. The work has been concentrated on better staple, higher gin outturn, better yields, and disease resistance. Some work on staples longer than 1 inch with American upland long staple has been done, but such strains or varieties have not been distributed to any extent as yet.

Bombay has always been an important cotton-growing Province. Its acreage represents on the average about 29 percent of that of the whole of India. Real or systematic breeding and improvement work began in the Province soon after 1900, as it did in the United States. The publication of Mendel's and of Johannsen's studies had its effects in India too. From that period up to the present Mollison, Fletcher, Gammie, Main, Shevade, Kottur, Kulkarni, Patel, Mankad, Prayag, Thadani, Desai, and others have been associated with the breeding and improvement work.

Kumpta cotton—a trade type named for a port south of Bombay, including a series of more or less indistinguishable varieties of the *Gossypium herbaceum* species—was one of the first of the native cottons turned to by breeders in the first decade of the present century.

[24] The growth over 1 inch in length is negligible or amounts to not more than 0.1 to 0.2 percent of the crop. Very little cotton produced in India is suitable for yarn above a count of 22. These longer cottons are mostly of the American upland type. However, one native variety, Surat 1027 A LF, is capable of producing counts from 26 to 34. Both American upland and native stocks are used for breeding better types of cotton in India. Egyptian and sea island have been less successful. The use of the native tree cotton is rather unpromising because of the very mixed condition of the types and the greater danger of insect damage.

Mass selection for long and fine staple was begun at the Dharwar Farm in 1904. From this came Dharwar I and Dharwar II, the latter highly resistant to wilt. From a cross between these two came Jayawant, meaning victorious—a name justified by the yield, ginning percentage, staple length, and wilt resistance. Dharwar III was developed from a cross between two strains of Kumpta, and Dharwar IV from a cross between Ghogari (*G. herbaceum*) and Kumpta.

Gadag No. 1 was developed from the Dharwar-American grown in the Dharwar district for a number of years. This stock was first separated by Gammie into two types, hairy and glabrous, and later the hairy type was found by Kottur to be resistant to a disease known as red leaf blight. From this came Gadag No. 1, which at present represents the Dharwar-American in the district.

Banilla cotton originated from a cross of two native species, Bani (*Gossypium indicum*) with fine long staple and Comilla (*G. cernuum*) with high ginning percentage.

Surat 1027 ALF came from a cross between Ghogari and Kumpta, and it is now the longest staple native Indian cotton (1 inch or better).

In the Broach area of Bombay a wilt-resistant variety designated as BD8 (Broach, *Gossypium herbaceum* × Deshi 8, *G. neglectum*) has been developed.

In northern Gujarat some breeding work on the native Wagad (*Gossypium herbaceum*) variety was done—the bolls of this cotton only crack and the cotton is hulled out in the farmhouses—which resulted in Wagad 4 and Wagad 8, and work has been in progress recently to cross the Wagad strains with Surat 1027 ALF.

In the Sind the native cotton was found to be made up of several varieties of *Gossypium neglectum*—Rosea, Cutchica, Vera, and Malvensis. Rosea was found to be superior and through plant selection the strain designated as 27 W N was evolved. Selection work with the Punjab-American strains has been carried on, as well as selection with sea island, Egyptian, and fresh American upland stocks, and many crosses have been made. Among the strains already developed can be found those suitable for most purposes. These cottons are now being tested all over the area in well controlled experimental trials. Crosses have been made of Punjab-American cottons with sea island, with Pima (Egyptian), and with the American upland variety, Meade. The progenies are under study, and in addition to direct plant-breeding work, information of value as to the inheritance of certain characters has been obtained.

In the Punjab, in addition to the Punjab-American 4 F, developed out of the narma or old Georgian type and occupying 1,000,000 acres by 1924, two others of this type were evolved—Punjab-American 285 F and Punjab-American 289 F. Two improved native varieties have also been grown extensively—Mollisoni, a selection from *Gossypium indicum*, and Roseum, a selection from *G. neglectum*.

In several of the other Provinces of India cotton-breeding work has been carried on. Two upland types have been utilized, Cambodia in Madras, and Cawnpore-American in parts of the United Provinces. In these two Provinces, as well as in other political divisions of India, more useful strains from native sorts have been developed.

In recent years in India much emphasis has been placed on fiber quality and disease resistance. As a whole, the Indian cotton crop has been improved in quality to some extent, and in certain areas

where the breeding work centered and better means of distributing the new stocks of seed have been worked out, much advance has been made. The greatest improvement in staple length has occurred in the Punjab, where American upland varieties have received the widest distribution.[25] Several well-defined wilt-resistant varieties have been developed in India in recent years.

Plant breeders in India have to overcome many traditional ideas and customs, and to contend with poor ginning management, inadequate methods of seed distribution, and poor marketing facilities. In spite of this they have already made a distinct contribution to the Indian cotton industry, and they are now so organized that much more progress in improving the quality of cotton will be made within the next few decades.

COTTON BREEDING IN CHINA

China ranks as the third largest cotton-producing country in the world. The 10-year average production in bales of 478 pounds for the period 1924–25 to 1933–34 was 2,150,100. This was 8.18 percent of the world production. Not until the present century did the crop become commercially important.

Ever since textile products became a commodity in international trade, China has been a cotton-importing country. With the dense population, food crops are strong competitors of cotton. However, fuel is also scarce and some cotton is required for padding clothing as a protection against cold. The short Asiatic cottons served the purpose until China developed a textile industry in the nineties, when she began to need better cotton for manufacture. This was supplied in part by importations of American and to some extent Indian cotton.

The development of the textile industry brought about the substitution of domestic for foreign goods, and the importation of raw cotton instead of textiles. The last step has been the effort to become self-sufficing in raw cotton. This has greatly stimulated cotton growing, and also improvement in quality. Much cotton of the short Asiatic type is still utilized domestically for hand manufacture and for padding clothing, but in the textile mills these native types are not suitable except for the coarse goods and wool mixtures. During the last 15 years, considerable effort has been made both to breed better native kinds and to introduce, adapt, and breed imported American upland varieties. China is on the way to supplying her own needs for cotton of the quality required by the native mills.

S. P. Peng, of the agronomy department, Nanking, writes as follows:[26]

> During the World War the cotton industry of China was given an opportunity to expand on account of the decreased world supply of cotton goods. On the other hand, the cotton mills found that the cotton produced inland did not meet their needs, either as to quantity or quality, so the improvement of cotton became of fundamental importance to the future of the cotton industry.
>
> Since 1915, the University of Nanking has undertaken experiments in cotton growing, particularly with reference to the introduction of American cotton, and has demonstrated the practicability of growing American cotton in the

[25] In 1915–16 about 80 percent of the total Indian crop was less than seven-eighths of an inch in staple length and the remaining 20 percent less than 1 inch in length. In 1923–24 the short staple amounted to about 67 percent and in 1933–34 to about 70 percent. None was estimated to be longer than 1 inch. In the last year or two staple longer than an inch has been reported and this is thought to have come from imported American varieties in the Punjab.

[26] In an article entitled "Acclimatized Varieties of Cotton—Trice and Acala," in Special Report No. 2, February 1935, College of Agriculture and Forestry, University of Nanking, Nanking, China.

vicinity of Nanking. Recognizing the importance of the cotton industry, the University has given much attention to the question of improved varieties. In 1919 a number of standard sets of cotton seed, representing widely different types of American grown cotton, were obtained from the United States Department of Agriculture, and variety tests were conducted in twenty-six centers, largely mission stations. . . .

During the year 1919, Dr. O. F. Cook, a cotton specialist with the United States Department of Agriculture, and Mr. J. B. Griffing, the head of the cotton work at the University, made a study in China on the behavior of both American and native cotton and on cotton problems in general. Some of their conclusions were as follows: (1) Trice and Acala, two acclimatized varieties, were fairly encouraging in the regions away from the coast and toward the North. (2) The superior strains of Chinese cotton in the lower Yangtze Valley indicate that there are great possibilities of improvement of the native stock.

With this in mind the University started a three-year program in 1920 in cooperation with the foreign cotton mill owners in Shanghai. . . .

Of the acclimatized strains, Acala and Trice, the latter was found to be especially good in the North because of its early maturity. The distribution of these acclimatized strains started in 1923.

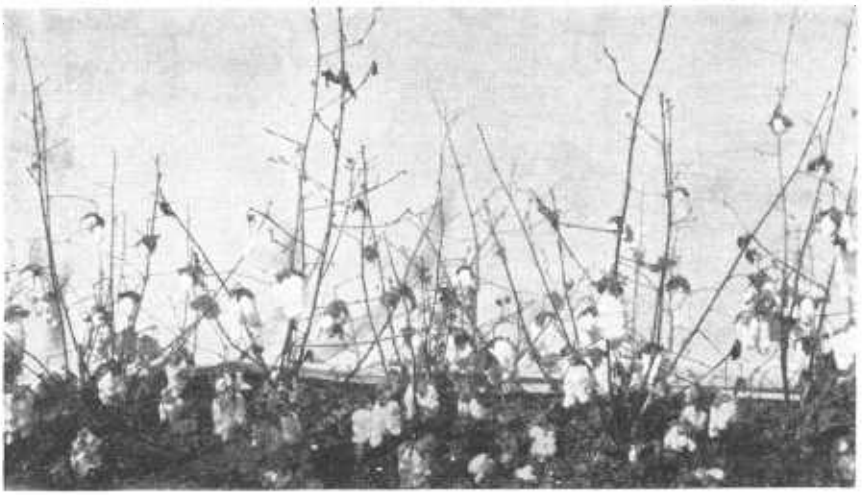

FIGURE 24.—A row of an improved selection of Chinese cotton called "Million Dollar" developed at the University of Nanking, China. Grown experimentally in California for breeding and genetics studies.

Concerning the improvement of a native variety (fig. 24), Y. S. Chen, also of the agronomy department, Nanking, writes:[27]

The "Million Dollar" variety was developed from a boll found in a farmer's field near Woosung, Shanghai, by Mr. J. B. Griffing in the fall of 1919. Chinese farmers pick their cotton frequently, and this was the only boll left unpicked on the plant. Although the boll was four-locked, only three locks of cotton with a total of twenty-one seeds were obtained. The same year more than a thousand other specimens from individual plants were selected from different places. These selections were given careful laboratory study and 300 of the most promising were planted in the spring of 1920 in a large breeding plot. Here the plants of each progeny were kept from crossing by covering all the blossoms with paper bags. Of all the progenies so grown, three gave great promise from the standpoint of both yield and quality, and their seed was carefully multiplied in isolated fields in 1921. The most promising of the three proved to be the one given the name "Million Dollar" by the students . . .

Inasmuch as experiments show that Million Dollar is the best among the varieties of Chinese cotton which have been tested, and as the mills are willing to pay a premium of more than 20 percent for this cotton due to its superior quality, all the cotton experiment and extension stations of Chekiang Province are now using this variety for multiplication and distribution to farmers. This will continue until another superior variety is produced through the breeding work at the stations.

[27] In an article in the same report entitled "'Million Dollar'—An Improved Variety of Native Cotton."

COTTON BREEDING IN EGYPT

Little was known of the culture or use of cotton in Egypt until 1800, when a French expedition found two very distinct species of cotton being grown there. One was a tree cotton grown in upper Egypt and the other an annual cultivated in lower Egypt or the delta district. About 1820 the perennial kind, which may have been of African origin,[28] was transferred to lower Egypt. This marked the beginning of commercial cotton culture in that country. The perennial cotton soon replaced the existing annual form and the latter apparently became extinct in lower Egypt.

The introduced tree cotton in the Nile delta soon attracted the attention of the spinners of the world because of the quality of its lint. Production was fostered by Government control, and it became the characteristic type of Egyptian cotton. The success of tree cotton in lower Egypt led to the importation of stocks of American sea island, Peruvian, other kinds from the West Indies and South America, and possibly upland.

The brown, long, strong lint and the almost naked seeds produced by this former tree cotton were typical of commercial Egyptian cotton for a hundred years thereafter, and the present Egyptian cotton is still of the same general type with some variations in length and color of fiber. The present type, however, is an annual and is classified as *Gossypium barbadense*, a definitely New World species. When the imported New World cottons were grown in the same area with the tree type, they perhaps hybridized with the latter. Possibly this particular African form of tree cotton was genetically compatible with the New World introductions. The modern Egyptian annual (fig. 25) developed either through this hybridization, followed by selection, or it evolved through gradual change from the perennial to the annual habit, somewhat as sea island became adapted to the southeastern United States.[29]

From 1820 onward there was a gradual development of the cotton-growing industry in Egypt until 1861, when 150,000 bales of 478 pounds were produced. The cotton famine of the American Civil War greatly stimulated production, and in 1864 Egypt produced about 400,000 bales. With the exception of slumps after the Civil War and during the World War, production has been on the increase until the last few years. The 10-year average production in bales of 478 pounds for the period 1924–25 to 1933–34 was 1,522,700 bales, or 5.85 percent of the world crop.

Before the beginning of modern plant breeding, much improvement work similar to that of the American sea-island growers doubtless was done in Egypt. Since 1904 Egypt has utilized modern methods, and these have resulted in distinct genetic improvement.

Perhaps the first variety of the modern type recorded in Egypt was Ashmouni. This was supposed to have been one of the segregates of the crosses between the perennial and the annual types. The Ashmouni stock, from the village of Ashmoun, was a brown-linted annual

[28] It might have been carried to upper Egypt, to Abyssinia, or to the Sudan country by the Arabs or some other roving tribes from the East, or it might possibly have been of American origin and carried to Africa by some ancient seafarers.

[29] If the tree cotton was either Asiatic or African in origin and belonged to the 13-chromosome group of the Old World assemblage, it would not have been expected to cross with the subsequent introductions from the New World. The tree cotton was either of New World origin or it was a peculiar Old World type that was genetically compatible with the American kinds. After the new sort became adapted to the production of the Egyptian type of staple, apparently the tree form gradually became extinct.

FIGURE 25.—Fields of Egyptian cotton in Egypt.

and has been referred to as old Brown-Egyptian. From the 1850's up to 1887 it was the principal variety grown.[30]

The Mit Afifi variety was developed from one or more plants found by a Greek merchant in Ashmouni stocks being grown near the village of Mit Afifi. The peculiar blue-green tufts of fuzz on the seeds of these plants attracted attention. On growing plants from these seeds, it was noted that the plants possessed decided advantages over the old Ashmouni cotton. The new type was developed and introduced commercially in 1887. It was an important variety in lower Egypt. The fiber was a richer darker brown than that of Ashmouni. It was long, very strong, and fine to the touch, and was in great demand for a number of years. Mit Afifi was also important as a parent of several later varieties. American-Egyptian was developed from it, and Dix-afifi, a Georgia wilt-resistant variety, came from a cross of Mit Afifi with the upland variety Dixie.

Because of the introduction of American sorts and the development of new variations out of the old hybrid complex, the Ashmouni stock was driven to upper Egypt, where it was reselected, purified, and again established with a new reputation.

Gallini, which is supposed to have had some Peruvian inheritance, was a very fine Egyptian cotton and controlled the fine-spinning market for a number of years, in the eighties and nineties. Abbassi, partly at least of sea island parentage, became a commercial cotton in 1893; Yannovitch, developed from Mit Afifi, in 1899; Nubari, developed from Ashmouni, in 1907; Sakellaridis or Sakel, in 1909; and Assili in 1910. The last two are supposed to have come from Ashmouni by way of Mit Afifi.[31]

Owing to the poorer development of irrigation in the upper Nile Valley and the virtual monopoly the long-staple Egyptian cotton enjoyed among the spinners of high-count yarn, the major part of the cotton crop of Egypt was grown in the delta, where this product of high quality could be produced to best advantage.

The Aswan Dam was built in 1903 and heightened in 1912. This greatly extended the cotton area now referred to as upper Egypt. The area is more suitable for growing staples of medium length. Since the World War the long staples, of which Sakel is the type, have not been in as much demand, many of the spinners finding that they can use an intermediate staple for much of the manufacture that formerly required the extreme lengths. As a result there has been a considerable demand for the staple length adapted for growing in upper Egypt.

In the market at present Egyptian cotton is referred to as Uppers and Lowers, from the upper Nile Valley and from the lower Nile Valley, though not all Uppers is grown in the upper Nile region. Uppers, which comprises the bulk of the Egyptian crop, is synonymous with Short and Lowers with Long in market parlance. Short-staple Egyptian cotton is longer than what is thought of as short staple in the United States. The length is from $1\frac{1}{16}$ inches to $1\frac{3}{8}$ inches. At this point the long staple represented by Sakel begins and

[30] Other varieties, later extinct, said to have developed out of the old hybrid stock were Gallini, Abiad Hariri, Bamia, Hamuli, Zahiri, and Sultani.

[31] Sultani and Valtos, Fathi and Charara were varieties of some importance in the nineties and the first decade of this century and were developed out of the old mixture of the two races. However, these disappeared some time ago. Sakel, grown in the delta or from Cairo northward, made up 77 percent of the Egyptian crop in 1921, and had replaced the older varieties, Mit Afifi, Abbassi, and Yannovitch. At that time Cazouli was a new variety similar to Sakel and was grown in lower Egpyt. In upper Egypt in 1921 Ashmouni produced 13.2 percent of the entire Egyptian crop and Zagora 7.2 percent.

runs up to 1½ inches or slightly longer. During recent years, however, a class of intermediate staple lengths has been established in the Egyptian market.

Several strains of Sakellaridis have been established but they are all considered in the market as belonging to the Sakel type. They are rather specialized in their adaptation and confined to the lower sections of the delta. A fairly new variety called Maarad, developed from Pima (American-Egyptian), is adapted to a wider area than the Sakel and has a higher gin turn-out, a slightly longer staple, but is somewhat weaker and more irregular in length. In recent years Maarad has increased in popularity in the delta. Others of the newer varieties in the long-staple group are Nahda and Giza 7, which are somewhat shorter in staple, give better yields, and are adapted to a wider area. The better yielding varieties of late years have increased rapidly at the expense of Sakel. The leading varieties of the medium 1¼- to 1$\frac{5}{16}$-inch staple are represented chiefly by Pilion and Fouadi, which were originated from the long-staple group. Grown in the lower Nile area, they also have been increasing at the expense of the Sakel type.

The chief varieties representing the short group are Ashmouni and Zagora, the former being grown in upper Egypt and the latter in lower Egypt. Between 1921 and 1935, the Sakel type decreased to 18 percent of the Egyptian cotton area, and Uppers—Ashmouni and Zagora—increased to 56 percent. The varieties of intermediate staple also became more widespread during this period. There has been a decided shift to shorter staples, and these have been bred for better yields. If well-bred varieties like Maarad, Giza 7, and Fouadi could be extended in the delta, and the improved strains of Ashmouni could be increased in upper Egypt, a considerable increase in the Egyptian crop would be brought about. Such a shift, however, will depend on the immediate demand for Sakel or other long-staple types and on efficiency in producing and distributing the newer varieties.

COTTON BREEDING IN THE UNION OF SOVIET SOCIALIST REPUBLICS

Cotton breeding and improvement in the Union of Soviet Socialist Republics has received considerable impetus in recent years. Until this effort became effective a considerable portion of the raw cotton for the Russian textile industry was imported. Outside of Transcaucasia, which is not particularly well adapted to cotton growing, Russia had no cotton-producing area until Turkestan had been conquered and taken into the empire about the middle of the nineteenth century. The cotton famine of the American Civil War stimulated cotton growing in the newly won territory and also to some extent in Transcaucasia.

Not much progress was made in obtaining suitable cotton from Turkestan and Transcaucasia until the short Old World sorts were replaced by introduced American upland varieties in the last quarter of the nineteenth century. During this period the development of railroads connecting the cotton regions with European Russia also materially aided both the expansion of cotton growing and the further development of the spindle capacity in Russian factories. Government aid was extended to farmers during a period before the World

War to encourage cotton growing. Plant breeders and other agronomic experts were also employed during this period to advise with the growers in handling and marketing the crop, and to breed the American upland varieties for better adaptation, better quality, and other improvements.

In 1915, 2,000,000 acres were grown, 88 percent of this in Central Asia (Turkestan) and the other 12 percent in Transcaucasia. This was the prerevolutionary peak year, and production was 1,500,000 bales of 478 pounds. The revolution brought a material falling off in production, but cotton growing took an upward turn again after 1922 and reached another high point of about 5,400,000 acres in 1932. However, since that year there has been some decrease, to 4,800,000 acres in 1934. Increase in total production has not kept pace with the enormous expansion in acreage. The acreage in 1933 was about two and one-half times as large as in 1927, but production gained only 70 percent. The 10-year average for the period 1924–25 to 1933–34 was 1,274,900 bales of 478 pounds, or 4.85 percent of the world crop.

There has been much effort on the part of the Soviet Government to increase yields and improve quality, but a great deal of this has been nullified by attempts to grow cotton in areas much less suitable to the crop than the old territory. However, in these new areas, which are in general north of the old belt and have a shorter season and a lower mean summer temperature, the present breeders have accomplished a great deal in breeding quicker growing and earlier fruiting varieties.

Replacement of Old World by New World kinds has been almost complete. The first attempts to introduce American cotton were made in Turkestan in the 1870's, with sea island cotton, but they proved unsuccessful. American upland, introduced during the next decade, was successful and soon practially displaced the Asiatic kinds. Practically all the Russian crop now ranges in staple length from ⅞ to 1 3/32 inches. The longer staples are due to the growth of Egyptian cotton.

With the reconstruction of the cotton-growing industry after political conditions became settled following the revolution, new varieties developed by Russian plant breeders, particularly the late G. S. Zaitzev and E. L. Navrotsky, were introduced on a commercial scale and soon became widespread. It has been estimated that the variety called Navrotsky, developed by E. L. Navrotsky from the American upland variety Russell, accounts for 70 percent of Russian cotton production at present. Strains of King, Mebane Triumph, etc., have also been adapted.

In the new cotton-growing regions only two rapidly maturing pedigreed varieties were to be planted according to the plan of 1934—Ak-Dghura No. 182 and Shreder No. 1306. In case of seed shortage a third, Dekkhan No. 169, was to be substituted. All three varieties have been developed within the past 20 years. The Soviet Government is now fostering a plan to grow the variety best suited to each region and to handle the seed stock in the best way from year to year.

Experiments with Egyptian cotton, begun in 1926 in Turkmenistan by the plant breeders Avtonomov and Krutzov, stimulated the introduction of this type of cotton on a commercial scale. In 1933 the area in Egyptian cotton was estimated at more than 160,000 acres, and in 1934 it was more than 250,000 acres. The most important

region for Egyptian cotton in the Soviet Union is Azerbaidjan in Transcaucasia. The Tadjik and Turkmen Republics in Central Asia are next in importance. Relatively little Egyptian cotton is grown in the Uzbek Rebublic, which is the most important cotton-producing region in the Union of Soviet Socialist Republics.

COTTON BREEDING IN BRAZIL

Cotton has been grown in parts of Brazil since European explorers found it there, but it did not gain much headway until the cotton famine caused by the American Civil War. The greatest impetus to cotton culture has come as a result of high prices of the commodity in relation to coffee and other products since the World War.

Up to recent times the cottons grown were the South America perennial types or Brazil tree cotton, and these types are still utilized rather generally in the northeastern commercial area. Toward the coast in this area, however, American upland has become established. On the other hand the present expansion of cotton growing in Brazil has come about chiefly through the introduction and successful adaptation of this annual form in the southern part of the country, where the crop had not been grown before.[32]

Rather early in the colonial period, around 1700, export shipments of cotton were made, and around 1775 spinning and weaving shops were set up in Minas Geraes, an area lying in what is classified as the southern region. Artisans from India were reported to have been brought by the Portuguese to teach their trade to the colonial mill operators. Not a great deal of expansion in either growing or manufacturing occurred until the American Civil War, when shipments of Brazilian cotton were said to have reached 368,000 bales of 478 pounds. However, after the cotton famine was over production in Brazil declined because of the low price of cotton from the United States, the competition from the growing of coffee, sugarcane, and rubber, and the freeing of the slaves in 1888.

With the decline of the rubber industry in Brazil in the early part of the present century, cotton culture began to come back. The World War brought higher prices for cotton, but the last few years have seen the greatest—and a rather unexpected—expansion. Over the 10-year period 1924–25 to 1933–34, the average Brazilian production was 590,800 bales of 478 pounds, which is 2.25 percent of world production. The estimated production for the year 1934–35, however, was 1,324,000 bales. This large increase occurred mostly in the southern States. During the 5-year period 1914–15 to 1918–19, only 20 percent of the average annual production occurred in the southern States, but in 1934–35 it was about 54 percent. Production in this area is chiefly in the State of Sao Paulo. Minas Geraes stands second, while much smaller amounts are produced in Parana and Rio de Janeiro. With the exception of some long-staple perennial cotton in Minas Geraes, the southern area is devoted entirely to the production of the upland varieties.

During recent years the Brazilian Federal Government and the various State governments have been active in the improvement of

[32] In the colonial period cotton was grown principally in the regions of Bahia, Pernambuco, and Maranhao, which lie in the northeastern part of the country between the mouth of the Amazon River and the port of Sao Salvador. The present northeastern area of cotton growing occupies this same section, with considerable expansion into adjacent States: Para, northwestward, toward the Amazon country; Piauhy, between Maranhao and Pernambuco; Ceara, Rio Grande do Norte, Parahiba, Alagoas, and Sergipe, toward the eastern portion of the continent. The northeastern-cotton growing area is north of south latitude 15° and more or less separated from the southern cotton-growing region, which is south of this latitude.

quality. This has been done partly by the importation of well-bred American varieties and partly by selecting and further adjusting their own varieties for local conditions. Government inspection and control of seed distribution has also been instituted. In 1932–33 the length of the staple of the Brazilian cotton crop according to estimates was distributed as follows: Less than ⅞ inch, 2.0 percent; ⅞ to 1 3/32 inches, 78.6 percent; 1⅛ inches and longer, 19.4 percent. However, Brazilian cotton is somewhat less satisfactory in character than American of these lengths, doubtless partly because of poorer ginning.

There are several varieties of the tree cottons in Brazil and they apparently belong to four different species.[33] Very little or perhaps no work has been done with these cottons in the way of selection and pure-line production, or even precise classification of various botanical forms. They are in a hybridized state to a considerable extent, and much work is needed to separate them and properly develop them into high-grade agricultural varieties.

The Russell variety of Truitt origin apparently was introduced into Brazil soon after it was developed in the United States. It became the basic stock for much of the upland cotton of the South, which is the upland cotton area. Other American upland varieties imported by Brazil at that period and later were Sunbeam, Upright, Cleveland, Durango, and Webber. These have become hybridized and mixed among themselves, and some of them at least have been crossed either naturally or artificially with some of the native tree cottons. One of these interspecific hybrids is known as Herbaceo Verdao. It is a quick-maturing variety well adapted to the more rainy regions in the coast areas. Paulo Sousa and Nova Paulista are annual hybrid varieties that have been reported, but it was not stated whether they originated from crosses of perennial with upland or whether they came from crosses between certain of the upland varieties themselves. Carioba is a hybrid originating from Webber and Russell.

Until recently very little breeding and improvement work has been done in Brazil beyond some sort of crude selection of new types resulting from mixtures and hybridization, and the distribution of these stocks and the imported American kinds. During the last few years, particularly since the country has become much more interested in cotton culture, several undertakings following more systematic methods of breeding have been inaugurated to improve the crop. Along with the genetic improvement of the varieties, much attention must also be given to controlling the seed supply, and to improving general methods of culture and ginning, marketing, and transportation facilities.

COTTON BREEDING IN PERU

The use of cotton for the production of textile materials in Peru is indicated by specimens found in prehistoric ruins. Cotton plants noted as growing in that country by the early European conquerors and explorers belonged to the perennial tree type, and probably were descended from a type believed by archeologists to have existed sometime in the remote past. Through the period of settlement and until about 1860, the native cotton was used by the white settlers.

[33] Moco, Serido, and Sertao belong to *Gossypium vitifolium;* Rim-de Boi, Creoulo, and Maranhao to *G. brasiliense,* syn. *G. conglomeratum;* Verdao and Rigueza to *G. peruvianum;* Quebradinho and Braziliero to *G. purpurascens;* and Algodao, Ganga (wild cotton), Algodao Vermelho (red cotton), and Macao (trade name), to *G. mustelinum* species.

The cotton famine of the American Civil War induced the Peruvians to expand cultivation on an export basis. New varieties from the United States and Egypt were imported and tested. It was found that the native tree cottons were not so well adapted to commercial culture as the North American and Egyptian annual kinds. However, after a period of temporary success, the industry lagged and did not again become important until the present century.

For the first 7 years of the century the average annual export of Peruvian cotton was about 37,000 bales of 478 pounds. For the 5-year period 1909–10 to 1913–14 Peru produced an average of 106,000 bales. During the 10-year period 1924–25 to 1933–34 the average production was 246,700 bales, and in 1934–35 the production was estimated to be 398,000 bales.

The present Peruvian cotton industry was made possible largely by the introduction of sea island and Egyptian cotton and the breeding of new varieties from these to suit the soil and climatic conditions of the country. Pima cotton, bred for suitability to the irrigated valleys of Arizona and California, has also been found to be adapted in Peru. The most important contribution of plant breeding to the Peruvian cotton industry, however, was the development of the Tanguis, a wilt-resistant variety, in 1918 from possible hybrids with previously imported stocks. Of the 1933 crop it was estimated that 92 percent was made up of this variety, with Pima ranking second.[34]

COTTON BREEDING IN MEXICO

There is little information about cotton breeding in Mexico, and doubtless whatever improvement has come about has been through a primitive type of selection of the native varieties or through importation of improved varieties from the United States. Although Mexico is probably the original home of American upland cotton, only 220,900 bales of 478 pounds were produced on an average in that country during the 10 years 1924–25 to 1933–34.

Cotton for domestic use is grown on a small scale in widely scattered regions in Mexico but commercial production is confined to a few areas. During the 4-year period 1930–31 to 1933–34, the Laguna (Coahuila and Durango) district produced 60 percent, the Mexicali (Baja California) 16 percent, the Matamoras (Tamaulipas) district 10 percent, and the Juarez (Chihuahua) district 5 percent of the Mexican cotton crop. The other 9 percent of the crop may be assigned to less important widely scattered sections. Within the major areas given, the annual production fluctuates considerably, however, because of price changes and internal political conditions.

The commercial cottons of Mexico are of the upland type, with the better staple types in the Mexicali district and the medium to short staples in the other districts. The length of staple in the Mexican crop apparently averages better than it does in the Cotton Belt of the United States.

COTTON BREEDING IN ARGENTINA

Cotton was being grown in Argentina at the time of the Spanish conquest in the early sixteenth century, and it is supposed that the plant was introduced from Peru or Bolivia at some earlier period. Dur-

[34] Peruvian Full-Rough, Peruvian Semi-Rough, Egipto or Suave, Mit Afifi, and Sakellaridis each made up 1 percent or less of the crop. The origin of Mit Afifi and Sakellaridis of course are well known. The rough and semirough Peruvian varieties came from the native sort, while the Egipto or Suave is thought to have originated from American upland cotton introduced into Peru during the American Civil War.

ing the American Civil War, British spinners distributed cottonseed and ginning machinery in the Argentine. Following this, cotton plantations were established, but they were abandoned after the commodity could again be obtained from the United States. Because of high prices during and after the World War, the Argentine Government, with the aid of American experts, started the development of the present cotton-growing industry. The acreage planted in 1924–25 was 258,000 acres and in 1933–34, 482,000 acres. The average production over the 10-year period 1924–25 to 1933–34 was 130,100 bales of 478 pounds.

The territories of Chaco and Formosa, with small acreas in the Provinces of Corrientes and Santiago del Estero, comprise the cotton belt of Argentina. Chaco is the most important and has produced 90 percent of the crop in recent years. In the last year or two the acreage in Santiago del Estero has expanded considerably, however.

The cotton crop in the Chaco territory is made up of the so-called Chaco type. It is believed that this originated from some of the natural crosses occurring among the various types of American upland introduced in the early part of the present century. The variety is a hardy type but has been found to have a mixed staple from ⅞ to 1 3/32 inches. Out of this variety efforts are now being made to isolate and establish a uniform strain with longer and more uniform staple.

In the Province of Santiago del Estero a long-staple variety, presumably of the upland species, is produced. The commodity grown in this area is of high quality and is extensively used by Argentine tire companies. The type doubtless resulted from the introduction of improved upland long-staple varieties from the United States, or it has been developed by breeders in that country. Presumably all or almost all of the Argentine cotton crop is of the upland species.

COTTON BREEDING IN UGANDA AND THE ANGLO-EGYPTIAN SUDAN

Cotton as a commercial crop has been grown in Uganda for some 30-odd years and the acreage has increased from a little more than 42,000 acres in 1910–11 to more than 1,000,000 acres in 1934–35. The 1934–35 production was estimated at 200,500 bales of 478 pounds. The 10-year average production for 1924–25 to 1933–34 was 162,600 bales of 478 pounds. The rapid expansion of cotton culture in Uganda, a British protectorate, has come about through the efforts of the British Cotton Growing Association in cooperation with the local government. Experiment stations, railroads, and better facilities for marketing have been established. Both adaptation studies of exotic varieties and breeding have been carried on at the experiment stations.

The cotton grown in Uganda is of the American upland type, and the present varieties are mostly developments from stocks brought from the United States 10 or 15 years ago. The country has considerable variation in soil and climatic conditions, but through breeding and adaptation of these American sorts several varieties have been adapted, one or more for each of the chief producing areas. The staple of the crop ranges from ⅞ to 1 1/16 inches in length.

The Anglo-Egyptian Sudan has been jointly controlled by Great Britain and Egypt since 1898. Cotton is probably indigenous, and if there was a center of origin in tropical Africa it may have been in

this part of the continent, or in some of the adjacent areas, such as Ethiopia (Abyssinia) or Uganda.

As a commercial crop, cotton has been developed in the Sudan since the British have had interests in the country. In 1910–11, according to estimate, a little more than 18,000 bales of 478 pounds were produced, but the industry did not become of much importance until after the World War. The 10-year average production for the period 1924–25 to 1933–34 was 123,800 bales. The largest annual production was in 1931–32, when the estimate was 206,000 bales.

In the Sudan, cotton is grown in six areas or sections under a variety of artificial and natural moisture conditions. The irrigated districts are Gezira, Tokar, and Kassala. The rain-grown cotton, which is unimportant, occurs in areas in the southern Provinces and in the Nuba Mountains. Since the Sudan is upper-Nile country, it is like Egypt in climate and soil, and much of the cotton acreage is planted to Egyptian Sakellaridis. American upland is grown only in the southern Provinces and the Nuba Mountains, where the moisture is furnished by rainfall, and in portions of the Nile Valley, where a pumping system is used. In this part of the Nile Valley, the temperature at fruiting time drops rather rapidly, causing a heavy shedding of fruit forms. Upland cotton seems to resist these conditions better than the Egyptian. The production of upland cotton in the Sudan has not exceeded 27,000 bales. The remainder of the crop is Sakellaridis.

The breeding and improvement work in the Sudan has consisted in the importation of varieties from Egypt and the United States, and in adapting these by selection and breeding to various localities or districts. There has been much effort to keep the seed pure by further selection and control of the seed supply on the farms. The cotton is marketed in the seed, and unless the seed cotton is carefully classified according to variety before ginning, this process mixes the seed stocks.

COTTON BREEDING IN CHOSEN AND MANCHURIA

Cotton growing in Chosen and Manchuria has been encouraged by the Japanese cotton spinners. Even before Korea (Chosen) was annexed in 1910 by Japan, cotton culture was fostered there by the Japanese. American upland varieties were introduced in 1906 and the production at present in Chosen from these stocks comprises about 75 percent of the crop. The American upland is cultivated principally in the southern half of the peninsula.

The staple length of the varieties from the upland stock ranges from ⅞ to 1$\frac{1}{32}$ inches. The native varieties, which comprise one-fourth of the Chosen crop, range in staple length from five-eighths to three-fourths of an inch in length. The American cotton is used for spinning while the native kind is used for domestically made textiles and the padding of clothing.

The cotton acreage in Chosen increased rapidly from 1910 to about 1925 or 1926, when the peak was reached. After that the acreage declined and then rose again after 1932, but the area occupied by the crop is not up to the 1926 level. Under the influence of the Japanese, some breeding work has been done, but even with this effort the upland cotton in Chosen is not equivalent in quality to that grown in the United States. The 10-year average production in Chosen for 1924–25 to 1933–34 was 133,700 bales of 478 pounds.

It is very recently that cotton production in Manchuria has been encouraged and expanded. This development also has been under the influence of the Japanese. In Manchuria 200,000 acres were planted in cotton in 1934 and 80,000 bales produced. About 60 percent of the crop is used for commercial spinning and 40 percent for bedding and the padding of garments. Only about 10 to 15 percent of the present production originated from American upland seed. Most of the area of Manchuria is too far north for profitable production of cotton. The plant is adapted to the southern part of the country only, and the native sorts, which are very early, do better generally than American upland.

At present organizations have been set up in Manchuria to improve the cotton industry through breeding better varieties both of the upland and native types, and to instruct the farmers in better cultural and marketing methods.

FIGURE 26.—Large perennial cotton plant on roadside in the town of Gressier, Haiti, West Indies.

OTHER DEVELOPMENTS ABROAD

Since the loss of the sea-island industry in the United States, the production of this cotton has been confined principally to the West Indies. One of the best cotton-breeding and cotton-genetic research institutions in the world has been established on the Island of Trinidad. The scientific and applied work in genetics carried on by S. C. Harland [35] and his coworkers at this institution is well known by cotton people all over the world. Especially in its more scientific aspects, this work serves the cotton interests of the whole of the British Empire wherever production is being attempted. A large perennial cotton plant in the West Indies is shown in figure 26.

The West Indies once produced a considerable quantity of commercial cotton. In fact, the industry began there before it did in the United States, but it was practically abandoned because of the competition of other tropical crops and the development of the American sea-island industry. After the latter succumbed to market de-

[35] Now General Genetics Adviser for the State of Sao Paulo, Brazil.

moralization and boll weevils, spinners turned again to the West Indies for long and fine fiber.

In the 40 to 50 other countries that grow cotton, including Manchuria, the 10-year average production from 1924–25 to 1933–34 was 549,400 bales of 478 pounds. Production in many of these countries is so unimportant, particularly for commercial use, that no attention has been paid to breeding and improvement.

The British Empire has been more successful in the development of cotton growing in her colonial areas than the other nations that hold possessions in potential cotton-growing regions of the world. As already noted, there has been much improvement in types and varieties in India, Egypt, the Sudan, Uganda, and the British West Indies through the influence of British manufacturing organizations.

Efforts are being made by the British to increase production in several of the less important cotton-growing countries in Africa. Belgium, France, and Portugal each have made some effort to grow cotton in their possessions in Africa, but not a great deal has been accomplished.

Appendix

Cotton Varieties and Strains Developed by Private Breeders in the United States

[Arranged in historical order, insofar as dates could be determined, except for certain groups listed under the name of a breeder or a locality]

Mexican: Brought by Walter Burling from Mexico City to Natchez, Miss., 1806. Introduced into South Carolina about 1816. Probably a big-boll type with short to medium staple. Considered by Tracy to be the stock from which most short- and medium-staple varieties have been developed.

Belle Creole: 1830–40. Originally in the hands of H. W. Vick, Vicksburg, Miss. Abundant lint; fiber long, firm, silky, soft, lustrous, oily; stalks large, tall, productive; bolls large, long.

Jethro: First recorded 1846. Developed by H. W. Vick from Belle Creole. Long staple; parent of Jones Long Staple, Six Oaks, and others.

Petit Gulf: About 1840. Originated by H. W. Vick. Plant large, straggling, late; bolls small; fiber ⅞ to 1⅛ inches; gin outturn 30 to 32 percent.

Boyd Prolific: Reported as common in Mississippi about 1847. Developed from a plant found in a field of ordinary cotton by a Mr. Boyd. Described as semicluster, with short fruiting branches, irregular joints; bolls medium size; lint short; gin outturn 30 to 32 percent. Parent of Dickson and other varieties important in Southeast.

Wyche: Developed after 1853 by a Mr. Wyche in Georgia from seed sent from Algeria.

Jones Improved: Propagated by J. F. Jones, Hogansville, Ga., from Wyche, after the Civil War. Parent of Truitt, Russell, Columbia, Keenan, Hartsville, Webber, and one of the parents of Culpepper.

Dickson: About 1858. Developed by David Dickson, Oxford, Ga. Cluster-type cotton.

Bohemian or Supak: About 1865. Developed by a Bohemian settler named Supak near Austin, Tex. Bolls large, storm-resistant, but easily picked; staple about fifteen-sixteenths of an inch. Progenitor of Rowden and Express.

Griffin: 1867. Developed by John Griffin, Greenville, Miss., supposedly from a cross of an upland variety known as Green Seed and sea island. One of the best of the upland long-staple varieties before the boll-weevil period.

Parker: 1868. Originated by John M. Parker, Sr., Maxime, Miss. Parentage unknown. Bender type; fiber medium length, high quality, strong.

Bancroft Herlong: About 1868. Some seed sent by a Mr. Herlong in Alabama to the editor of the Southern Cultivator were turned over later to Edward Bancroft, Athens, Ga. After first trial, the variety was mixed with an early variety thought to be Dickson. Bancroft Herlong was developed from this mixture.

Peterkin: About 1870. Originated by J. A. Peterkin, Fort Motte, S. C. Resembled Rio Grande type; seed reported to have been brought originally by a man named Jackson from the back part of Texas. Considered preeminent for poor soil and hard growing conditions before the boll weevil period.

Dearing: About 1870. Probable originator, J. J. Dearing, Columbus, Georgia. Parent material not known. Object, high lint percentage (it is stated that 45 percent was attained). Short staple, resembled Peterkin.

Hagaman: About 1877. Selected by F. V. D. Hagaman, Jackson, La. Parent material probably a variety known as Deane. Plant rather large, rather late; bolls small; lint of good quality, length about 1 1/16 inches; seed nearly smooth or sparsely fuzzy.

Keno: Probably prior to 1880. Also known as Maud Adkin, Eureka, and Colthorp. Originated by Maud Adkin, a Negro, by selection of best plants of common cotton for 3 consecutive years. Stocks later sold to A. S. Colthorp, Talla Bena, Madison Parish, La. Plants large, rather late; staple very fine, strong, silky, 1 1/8 to 1 3/16 inches in length. One of the most popular varieties.

Southern Hope: About 1880. Originated by F. Robiew, Louisiana. Parent seed said to have come from Peru. A good long-staple variety, length about 1 1/4 inches. Around 1900, Marx Schaefer took up the growing and selecting of this variety for several years.

Cobweb: 1881. Developed by W. E. Collins, Mayersville, Miss. Reported to be a cross between the upland variety Peeler and an Egyptian variety. Plants of upland type, long limbs, late maturity, staple length 1 3/8 to 1 1/16 inches.

Welborn Pet: 1881. Developed by Jeff Welborn, New Boston, Tex. Said to be a cross or blend of Barnes (dense growing, broad leaf, green seed), Jones Improved, and Zellner (a very small clustered cotton probably developed from Boyd Prolific). Plants of cluster type, tall, slender; bolls medium size; lint short, about seven-eighths of an inch.

Drake: 1882. Originated by R. W. Drake, Greensboro, Ala. Selected from Peerless (semicluster type); resembled parent, but somewhat earlier and more clustered. Very popular in several States, especially Georgia and South Carolina, for a number of years, but rather susceptible to anthracnose.

Peerless: Prior to 1880. Originator unknown. Perhaps originated in Georgia. Parent of Drake and several other varieties. One of the best short-staple varieties for a number of years previous to 1900 and widely grown. Staple length seven-eighths to fifteen-sixteenths of an inch.

Jackson Round Boll: 1897. Originator, James Jackson, Preston, Tex., by mass selection beginning 1882, followed by propagation of one ideal plant. Grown rather widely in Texas for a considerable period. Bolls large, storm resistant; plant vigorous; lint 35 percent; staple length seven-eighths to fifteen-sixteenths of an inch.

Braddy: 1884. Developed by L. C. Braddy, Little Rock, S. C., by selection from Simpson. Grown to a considerable extent in parts of South Carolina for several years. A short-staple variety, similar to those of the Peterkin group.

Cook Long Staple: 1884. Developed by W. A. Cook, Newman, Miss., from a single plant selected from a field of common cotton. Plant vigorous, late, much like Allen Long Staple; staple length 1 3/8 to 1 1/16 inches. A leading variety in the Mississippi Valley for many years.

Shine Early: About 1885. Originated by J. A. Shine, Faison, N. C., who considered it a hybrid between sea island and some short-limbed, cluster, upland variety. Plants tall, quite pubescent. Bolls small; locks fell out badly during wind and storms. Staple about seven-eighths of an inch in length.

Truitt: 1885. Developed by George W. Truitt, Lagrange, Ga. Objects—prolificacy, big bolls, and as much earliness as possible. Staple length seven-eighths to fifteen-sixteenths of an inch. According to the originator, Truitt was developed by selection from a variety known as Old Georgia White Seed. According to Tyler and Webber, the parent of Truitt was most certainly Wyche or some one of its derivatives. It seems likely to have been Jones Improved. The Old Georgia White Seed could easily have been from Jones Improved stocks.

Rogers or Rogers Big Boll: About 1888. Developed by R. H. Rogers, Darlington, S. C., by mass selection from a mixture of Jones Improved, Bancroft Herlong, and another variety known as Jowers. Rogers giving his personal attention to the work each year for 15 years. Very desirable variety but somewhat late, an unfavorable characteristic after the arrival of the boll weevil. Semicluster in type. Bolls round with blunt apex, rather large. Lint about 32 percent, staple length seven-eighths to fifteen-sixteenths of an inch.

Culpepper: Developed by 1890. J. E. Culpepper, Luthersville, Ga. Possibly a hybrid between Wyche or Jones Improved and Dickson. A big-boll cotton

but plants somewhat semicluster in habit. Staple length, seven-eighths to fifteen-sixteenths of an inch, gin turn-out around 35 percent. Reported to have been more hardy than either parent except for anthracnose susceptibility (carried over presumably from Dickson). Staple reputed to be of better quality than Jones Improved or Dickson.

Cleveland: Came into prominence about 1890. Developed by J. R. Cleveland, Decatur, Miss., by 25 years of mass selection. Parent material not known. Not very uniform—plants both open type and semicluster. Bolls medium to large, little stormproofness, staple about fifteen-sixteenths of an inch. Reported to be early in maturity. Never distributed, but very important as parent of Wannamaker Cleveland, Piedmont Cleveland, and the other present-day Cleveland strains.

King or King Improved: About 1890. Originated by T. J. King, Louisburg, N. C. (later seed merchant at Richmond, Va.), from a stalk of very prolific cotton found in a field planted to the old Sugar-Loaf variety. Not very different from parent variety. King became famous as a variety and with Sugar-Loaf was widely used along the northern part of the Cotton Belt, and, for a period immediately after the incoming of the boll weevil, almost throughout the cotton-growing area of the United States. Both were short, early, wasty cottons, with very little storm resistance and small bolls. Now practically replaced by new varieties of better quality.

Jackson Limbless: 1894. Introduced by T. W. Jackson, Atlanta, Ga. Similar to Shankhigh in type. Plants much taller, fruiting zone higher from the ground than with most of the other cluster varieties. Bolls small, round, crowded together on very shortened branches. Staple short, about seven-eighths of an inch.

Hawkins: About 1895. Developed by W. B. Hawkins, Nona, Ga., according to Tyler, from a mixture of New Era, Peerless, Dickson, Bancroft Herlong, and some others. Plants fairly early; bolls somewhat clustered, medium in size; staple short, about seven-eighths to fifteen-sixteenths of an inch; lint percentage high for that period, around 36 percent. Grown widely over the Cotton Belt for a number of years.

Russell: 1895. Originated by J. T. Russell, Alexander City, Ala., from a single plant selection out of impure stocks of the Truitt variety. Considered by the originator a chance hybrid of Truitt with Allen Long Staple. This might explain the presence of long-staple plants found in the variety by H. J. Webber a few years later and developed into the Columbia variety. Plants large, vigorous; bolls large, with considerable stormproof tendencies; rinds thick and protective against boll weevil; fiber, $1\frac{5}{16}$ to 1 inch in length; lint percentage rather low for short cotton; seeds covered with dark-green fuzz which injured the linters sample and sometimes the lint sample, particularly if gins were adjusted to cut the seed close.

Toole: About 1895. Developed by W. W. Toole, Augusta, Ga., from a single plant selected out of a crop of Peterkin for its short joints and numerous bolls. Well adapted to rich, well-cultivated soil, not inclined to develop excessive vegetative growth. Plants somewhat similar to Peterkin but more inclined to semicluster habit. Bolls larger, staple somewhat longer—about fifteen-sixteenths of an inch. Apparently produced seeds pure for fuzz covering, whereas in Peterkin there was a tendency for some black or nearly naked seeds to occur. Noted for high lint percentage and a certain degree of wilt resistance. Parent of several later strains noted for wilt resistance.

Cook or Cook Improved: 1895. Originated by J. R. Cook, Ellaville, Ga., according to his statement, from a natural cross between a local Georgia variety known as Beat-All and a small-boll cluster variety thought to be Dickson. Intermediate in type between parents. High lint percentage, early in maturity, bolls medium in size, staple about seven-eighths of an inch. Not uniform, but served as parent material for other varieties, including Half and Half, Rhyne Cook, and a number of Cook strains selected by the Alabama Agricultural Experiment Station.

Coxe Yellow Bloom: 1896. A rather unusual variety in that it possessed petals clear lemon yellow in color and without spots. Developed by E. A. Coxe, Blenheim, S. C., from a plant thought to be a cross between sea island and the upland variety, Texas Wood (a synonym for Peterkin). Resembled the Peterkin type with the exception of the unusual bloom color. Bolls medium in size; lint percentage high, about 39 percent; staple short, seven-eighths to fifteen-sixteenths of an inch.

Boykin Stormproof: Probably in the 1890's or earlier. Originated by W. L. Boykin, Kaufman, Tex. Parent material probably Texas Stormproof (an older variety developed by W. J. Smilie of Baileyville Tex., which according to Tyler,

resembled Bohemian and Myers). Plants late, large, stocky; fruiting branches long and long-jointed; bolls large, protected from storm damage by turning down, by the shielding effect of the broad bur segments, and by the clinging together of the locks in one mass. Lint percentage moderately high, around 34 percent; staple variable but commercially about 1 1/32 inches. With Texas Stormproof, has been grown widely in the Cotton Belt where these varieties were not too late in maturity for the locality.

Mebane Triumph: 1900. Selected and introduced by A. D. Mebane, Lockhart, Tex. Name given by Seaman A. Knapp. Mrs. Mebane, Paul M. Mebane, a brother-in-law, and W. P. Patton, Jr., a nephew (A. D. Mebane Estate), have continued the work since the originator's death in 1923. However, after 1929 Paul M. Mebane became plant breeder for the A. D. Mebane Cotton Seed Co., a separate firm located in Lockhart. This company has maintained its own stocks of Mebane Triumph since 1929 and in that year Paul M. Mebane selected an outstanding plant whose progeny provides the present seed supply. This strain was introduced in 1934. From 1907 to 1929 the A. D. Mebane Cotton Seed Co. grew and marketed seed which were from stocks provided by the originator, A. D. Mebane.

Allen Long Staple: About 1898. Developed by James B. Allen, Port Gibson, Miss. Extensively grown throughout the Delta of Mississippi and other long-staple districts until the boll weevil period. According to Allen, a cross between Yellow Bloom and Allen Hybrid, previously introduced by him, but of unknown parentage. (No connection has been traced between Allen Yellow Bloom and Coxe Yellow Bloom.) Plant rather tall, semicluster; bolls small to medium in size, seeds fuzzy and white, fiber very long and silky, about 1 1/2 inches in length.

Sunflower: About 1900. Developed by Marx Schaefer, Yazoo City, Miss. Parentage unknown—original seed obtained from a local oil mill. Rather distinct in appearance from other sorts. About 10 days earlier than Allen Long Staple or Griffin; almost as early as King. Plants tall, pyramidal, with some tendency toward semicluster habit. Bolls small; lint percentage low; seeds fuzzy; staple very fine, long, silky, measuring about 1 3/8 inches in length. Was grown to a considerable extent in the Mississippi Valley until replaced by better and subsequently bred varieties, and has been a parent of some of the important hybrid varieties.

Pride of Georgia: 1903. Originated by J. F. Jones from his older variety, Jones Improved. Inclined to fruit and mature earlier than parent; staple length about fifteen-sixteenths of an inch. Pride of Georgia was quite widely grown over most of Cotton Belt for several years.

Shankhigh or Upright: About 1904. Originated by M. L. Branch, Bishop, Ga., from a single upright type of plant found in his field of the Russell variety. Plants grow very tall, develop a long central stem with one or two large branches which also turn sharply upward. Bolls develop rather high on the stalk, are very round in appearance and of medium size. Staple seven-eighths to 1 inch, averaging about fifteen-sixteenths of an inch.

Half and Half.—Originated about 1904. Developed by H. H. Summerour, Duluth, Ga., from the Cook variety, by plant selection, plant-to-row comparison, and progeny strain testing. Plants medium early, rather compact; leaves only moderately abundant, of medium size; bolls medium size, rounded; fiber length, five-eighths to seven-eighths of an inch; lint percentage usually 40 to 46 percent. Came into prominence about 1911. Extensively grown in hill- and poor-land regions east of the Mississippi River. More recently, grown on corresopnding soil types west of the river, and in the short-cotton areas of western Texas and western Oklahoma.

Hibred: 1930. Developed by B. F. Summerour from a cross of Half and Half and Durango. Staple somewhat better than Half and Half but gin outturn somewhat lower. Grown to some extent in several States but not distributed extensively as yet.

Rowden: About 1905. Developed by Will Rowden, Wills Point, Tex. Stock originated from two bolls brought from the Sulphur Fork River bottoms about 50 miles northward and was thought to be of the Bohemian variety. The Rowden variety was bred by mass selection and kept reasonably true to varietal type by this method for many years. A large-boll variety. Has been widely grown in many areas in the western part of the main Cotton Belt, and is the parent of Arkansas Rowden 40, Hurley Special, Sunshine, and other later selected strains.

Wannamaker-Cleveland: Developed from the Cleveland variety by the plant-to-row method by W. W. Wannamaker, St. Mathews, S. C. Selection work started in 1908, but the new variety did not become prominent until 1916. Earlier, lower growing, more spreading, more prolific, with smaller bolls than the original Cleveland. Boll rounded, medium in size; gin outturn from 38 to 40 percent and sometimes higher; staple length, ⅞ to 1 inch. Widely grown for a number of years, but due to shortness of staple has now been practically replaced by more recently developed varieties. Parent of a number of varieties which have been derived either by straight selection or by hybridization.

Wannamaker-Cleveland Wilt Resistant: Developed from a single plant found in 1927 in the original Wannamaker-Cleveland variety. Thought to be a natural hybrid of the latter with Super Seven. Earlier, larger boll, higher lint percentage, longer staple than Wannamaker-Cleveland. Wilt-resistant; staple length 1 1/16 inches, but many of the seeds partly devoid of fuzz. Introduced as a new wilt-resistant variety about 1931, but further distribution soon discontinued by the producer because of the presence of black seeds.

Wannamaker-Cleveland "Standard": A newer strain of short staple developed from the original Wannamaker-Cleveland variety, but being discarded by the breeder because of the shortness of the staple.

Wannamaker-Cleveland Staple: A new long-staple strain which is taking the place of all other Wannamaker-Clevelands. Said by the breeder to have the qualities of Wannamaker-Cleveland and in addition 1 1/16-inch staple and wilt resistance. Sparse fuzz eliminated.

Dixie-Triumph Strain No. 1 (introduced 1931) *and Strain No. 2* (more recent): Developed by W. W. Wannamaker and said by him to have several improved features over the original Dixie-Triumph. Reported to be more prolific, earlier, of more compact form, with larger bolls and better staple.

Piedmont Cleveland: Developed by J. O. M. Smith and M. W. H. Collins, 1912 to 1919, and introduced to farmers in 1919. Has been very popular and widely grown. Resembled the parent Cleveland in habit but earlier, more uniform, more prolific. Stock has been kept fairly pure to the present time by renewal with strains developed later, but type has not been changed materially.

Strains introduced by the Bouknight Bros. of Johnston, S. C.: Dixie-Triumph Short Staple (1927), developed by B. B. Bouknight; Dixie-Triumph Long Staple, and Cleveland Short Staple (the latter from Wannamaker-Cleveland), developed by W. M. Bouknight; Cleveland Staple (from Cleveland 5) and Cleveland Big Boll (from Wannamaker-Cleveland), developed by J. H. Bouknight. The new Dixie-Triumph strains were the product of further selection from older stocks of the variety for wilt resistance, earliness, a particular fiber length, greater uniformity in general. The three Cleveland strains resulted from selection respectively for extra staple length, high lint percentage, larger bolls.

Marett Cleveland 5–5, Marett Cleveland 5–35, Marett Cleveland 6B–7—all from Wannamaker-Cleveland, and developed 1920 to 1925; Marett J. K., from Bottoms, developed in the same period, by the Marett Farm & Seed Co., Westminster, S. C. This firm also developed Dixie-Triumph 4 (1933), from the original Dixie-Triumph; Carolina Dell (1933), from Delta & Pine Land 4–8; Marett 100 (1926), from a cross of Marett J. K. and Delta & Pine Land 4–8. Objectives in improvement of the Marett strains and varieties—better yield, a staple length around 1 to 1 1/16 inches, a high lint percentage. Dixie-Triumph 4 also selected for more wilt resistance. The plant breeders of the Marett Farm & Seed Co. are K. W. Marett, J. E. Marett, and W. T. McClure, Sr.

Woolsey Cleveland: Introduced about 1924. Selection begun in 1918 from Wannamaker-Cleveland by C. B. Woolsey, Aiken, S. C. Vigorous growing strain, productive, gin outturn 37 to 38 percent, staple ⅞ to 1 inch. Several additional strains of Woolsey Cleveland developed in recent years.

Wannamaker-Cleveland strains: Developed by J. E. Wannamaker & Son, St. Mathews, S. C., by selections beginning in 1917. First strain seven-eighths to fifteen-sixteenths of an inch staple, gin outturn 37 to 38 percent. More recent strains, 15/16 to 1 inch staple. Two strains of Dixie-Triumph also introduced by this firm since 1932.

Dixie-Triumph 1, 9, 12, 25, 29: Developed by L. O. Watson. Among the more satisfactory of the present Dixie-Triumph stocks for wilt resistance and varietal utility in general. Watson Long Staple also developed by this breeder.

Strains and varieties developed by Coker's Pedigreed Seed Co., Hartsville, S. C.:

Hartsville: 1907. Breeding instituted by D. N. Shoemaker and W. C. Coker from Jones Improved. Development completed by D. R. Coker. Staple

length, 1⅛ to 1 3/16 inches. Further improved by D. R. Coker and assistants through selection of 21 consecutive strains for uniformity of type, staple length (finally brought up to 1¼ to 1⅜ inches), and quality. Discarded after 1922 because late maturity made the strain so subject to boll weevil damage that it would not survive.

Columbia: Distributed in 1907. Parent, a strain selected from Russell in 1902 by H. J. Webber, near Columbia S. C. Staple length 1 5/16 to 1⅜ inches.

Webber 49 (1910) *and Webber 82* (1915)*:* Developed by progeny selection from seed obtained from Webber by Coker in 1907. Was developed into a strain uniform, productive, staple 1¼ to 1⅜ inches. Webber 49, earlier, slightly the better staple, survived the boll weevil until 1928 and was selected through six consecutive strains. Webber 82 was selected through several consecutive strains, two of which were distributed but did not survive the boll weevil. However, Webber 82 was an important blood line and was the parent of Deltatype Webber.

Deltatype Webber: 1922. Selection from Webber 82–5–16 for earliness. Nine consecutive strains isolated, the last introduced in 1933. The best, most successful, most widely grown of the long-staple types produced by the Coker's Pedigreed Seed Co. through straight selection. Uniform, productive, splendid fiber quality, staple 1¼ to 1 5/16 inches. Important as a parent of more recent hybrid strains or varieties, the most important being the Wilds strains, which superseded the Deltatype Webber type.

Lightning Express: Eight strains developed, 1922 to 1932. Parent material, Express 28–350, obtained in 1917 from E. C. Ewing, of the Delta & Pine Land Co., Scott, Miss. All somewhat wilt resistant, but strains 5, 6, 7, 8 especially so. George J. Wilds, since 1922 head of the plant-breeding staff, has noted three forms of wilt in South Carolina, called the Hartsville, Sumter, and Manning forms. Lightning Express 8 is resistant to the first two, but slightly susceptible to the last. These strains were the most widely distributed Coker cottons from 1922 to 1928; grown all the way across the humid portion of the Cotton Belt. Early, prolific, staple 1⅛ to 1 3/16 inches.

Super Seven: 1925. Several strains introduced over a period of years. Developed from a chance hybrid of Webber 49 and Dixie. Wilt-resistant, early, prolific, staple 1 5/16 to 1⅜ inches. Widely grown for a few years but superseded by Clevewilt strains, more suitable general-purpose type.

Wilds: Six strains distributed, 1928 to 1935, from Deltatype Webber × Lightning Express, cross made by Webber and Wilds in 1919. Grown in Mississippi and Arkansas bottomlands and certain long-staple areas in eastern part of the Carolinas. The later strains are the longest type of upland cotton grown today. Significant as indicating the importance of hybridization for further improvement of the cotton crop.

Coker Cleveland 5 (1926), *Coker Cleveland 884* (1928)*:* Seven strains of the former and four of the latter distributed. Developed from Wannamaker-Cleveland by selection, plant-to-row and progeny testing, beginning in 1918. Objective: To provide varieties of intermediate staple length (1 to 1 1/16 inches) for general growing. Have played an important part—especially the Coker Cleveland 5—in improving staple length and quality of South Carolina crop; also used effectively in improvement programs of surrounding States.

Farm Relief: Three strains introduced, beginning in 1931. Developed by Wilds from strains of Cleveland crossed with strains of Lightning Express in 1921. Earliest and quickest fruiting of Coker cottons. Foliage thin, plant open, bolls large, lint percentage high, staple 1 1/32 to 1 1/16, quality excellent.

Coker Clevewilt: Five strains distributed, beginning in 1931. Developed by series of selections from progenitor line of Cleveland 884, repeatedly grown on wilt-infested land. Highly resistant to wilt—strains 4 and 5 resistant to Hartsville and Sumter forms, strain 5 thought to be resistant to virulent Manning form. Productive, staple 1 1/32 to 1 1/16 inches, gin outturn 37 to 38 percent.

Coker Foster: Six strains introduced, beginning in 1926. Five developed by pedigree selection from Delfos 6102, one (strain 4) from Delfos 631. Delfos seed obtained from H. B. Brown of the Mississippi Agricultural Experiment Station in 1920. In the last decade some lines of Delfos 911 (6102 type) have been selected for nine generations on badly infested soil to increase wilt resistance.

Strains developed by Humphrey-Coker Seed Co., Hartsville, S. C.:

Cleveland 20: 1924. Outstanding fifteen-sixteenths to 1-inch strain, early and productive. Selected from Wannamaker-Cleveland in 1920.

Dixie 14: First introduced in the early 1920's. Selected from original Dixie; seven additional strains developed later. Objectives: Less clustered type than Dixie, earlier, better staple, more wilt resistance. Probably the most wilt-resistant of cottons, over a wide area. Whether they are resistant to all physiologic forms of wilt is not known.

Carolina-Foster: 1924. Selection from Foster 120, obtained from H. B. Brown of the Mississippi Station in 1920. Small early type similar to Delfos 6102.

Seven strains bred; from these Delfos 6102–38 and Delfos 6102–54 were isolated in 1926. Four strains from the former and three from the latter developed since 1926. Foster 13–46 Excelsior strains (from Carolina Foster strain 2), developed in 1930, is an outstanding long cotton. All Foster stocks early, prolific, staple 1 1/16 to 1 1/32 inches.

Delta 36: 1928. From Webber 82. Four strains subsequently developed. Long-staple type similar to Deltatype Webber.

Cleveland 52: 1928. From Wannamaker-Cleveland. Four strains subsequently developed.

Dixie-Triumph 4: 1930. From Watson Dixie-Triumph. Two strains with 1 1/16-inch staple developed later—Dixie-Triumph 44–12 and Dixie-Triumph 4–3.

Other important wilt-resistant varieties developed by private breeders in recent years:

Rhyne Cook: About 1921. A prominent variety, still grown on a very large acreage in Alabama and Georgia. Developed by the Rhyne Bros., Benton, Ala. Parent, Alabama Experiment Station strain Cook 307–6. Staple seven-eighths to 1 inch, gin outturn 36 to 40 percent, boll size 70 to 80 to the pound; easily picked, high yield, marked wilt resistance. In recent years C. L. Rhyne, Americus, Ga., has continued Rhyne Cook by mass selection.

Bottoms: About 1915. Developed by A. T. Bottoms, Athens, Ala., from a Texas variety, probably Mebane Triumph. Dwarf type, semicluster, extra early, fast in fruiting, bolls of medium size, staple length seven-eighths to 1 inch. Did not become very prominent.

Rucker: Developed 1912 by Rucker Bros., Alpharetta, Ga. Parentage, an accidental cross between King and Cook. Rather extensively grown, especially in Georgia and Alabama, but now largely superseded by more recent varieties. Rucker No. 11, introduced in 1931, is thought to be a natural hybrid from the original Rucker and one of the Webber strains. Within the last year or two popularity has waned somewhat.

Addison: Originated by W. P. Addison, Blackwell, Ga., perhaps from Half and Half. Grown to a considerable extent a few years ago in Georgia but at present less popular.

Sikes Early Big Boll (probably from Wannamaker-Cleveland), *Sikes No. 7, and Sikes Wilt Resistant* (probably from Dixie-Triumph): The Sikes varieties occupied a moderate acreage in Georgia from 1928 to 1934.

Covington-Toole: 1900–1910. Developed from Toole by W. F. Covington, Headland, Ala.

Mathis-Toole: 1900–1910. Developed from Toole by W. J. Mathis, Dawson, Ga.

Perry-Toole: 1900–1910. Developed from Covington-Toole by J. P. Perry, Dawson, Ga.

Petty-Toole: 1900–1910. Developed by H. A. Petty, Dawson, Ga.

Brim-Toole: 1900–1910. Developed by J. E. Brim, Dawson, Ga.

Council-Toole: 1900–1910. Developed by M. B. Council, Americus, Ga.

Sam Wood: 1900–1910. Developed by Samuel Wood, Abbeville, Ala.

Strains and varieties developed by the Delta & Pine Land Co., Scott, Miss.:

Salsbury: Developed 1916–22. Product of a single cross of an extra early, prolific Wannamaker-Cleveland plant as female and one of the best Express 15 plants as pollen bearer. Quite early, bolls medium size, staple 1 1/16 inches, gin outturn 31 to 34 percent, highly disease resistant, one of the best yielders of its time. Widely grown over the humid part of the Cotton Belt until replaced by more recent improved varieties.

Delta & Pine Land 4 and Delta & Pine Land 8: Developed 1917–25. Product of a Polk (long-staple local variety) by Mebane Triumph cross. Even more popular and widely grown than Salsbury during the period 1928–32. Now discontinued by originator but still survives in many places. High gin outturn, hardy, high yield, moderately early, boll medium size, staple 1 1/16 inches, fairly disease resistant.

Delta & Pine Land 6: Developed 1919–27. Derived from a single cross of Express 122 and a strain of Foster 11 (sister selection of Foster 120). Never widely grown, occupying only few thousand acres in 1928 and 1929. Early, very disease resistant, productive, gin outturn high for the length of staple, staple 1 1/8 to 1 3/16 inches. Did not become widely popular because of small, tight, pointed bolls. Discontinued several years ago.

Delta & Pine Land 10: Developed 1919–27. From a cross between an unnamed noncommercial hybrid and an Express selected line. One of the most productive strains introduced in the Cotton Belt. Early, staple 1 1/16 inches, boll medium size, gin outturn 33 to 37 percent, moderately wilt-resistant. Still widely grown in the humid parts of the Cotton Belt.

Delta & Pine Land 11: Developed 1928–34 from a cross between Delta & Pine Land 10 and an unnamed noncommercial hybrid. Outstanding for high lint percentage (37 to 42 percent), slightly longer staple. Early, staple 1 1/16 to 1 3/32

inches, boll medium size, fairly disease-resistant, perhaps more productive than Delta & Pine Land 10. Rapidly gaining popularity in many areas since its recent introduction.

Delta & Pine Land 11A: A selection from Delta & Pine Land 11 for more uniformity and a slight increase in staple length. Not yet distributed among growers but will replace its parent strain on properties of originator in 1936.

Strains developed by the Stoneville Pedigreed Seed Co:

Stoneville 1, Stoneville 2: Developed 1923–28 and introduced commercially in the latter year. Widely grown; Stoneville 2 popular in Georgia as stocks for one-variety community production. Staple 1 to 1 1/16 inches, high lint percentage, easily picked, unusually productive. Selected from Lone Star 65.

Stoneville 3: Developed 1925–30. Selection from Stoneville 2. Earlier but not especially superior to parent. Used as the breeding line for Stoneville 5.

Stoneville 4: Developed 1926–31. An improved selection of Stoneville 1, which it replaced on the originator's farms in 1933. Larger boll, better lint percentage, higher productivity, more uniformity in general.

Stoneville 5: Developed 1927–32. Selection from Stoneville 3. One of the best Stoneville strains for high lint percentage.

Stoneville 2A: 1928–33. Selection from Stoneville 2 for larger bolls, more uniform fiber of better quality. Replaced Stoneville 2 on the originator's farms in 1932.

Stoneville 4A: Developed 1929–33. Selection from Stoneville 4, representing further improvement over parental line in boll size, lint percentage, ease of picking, uniformity of fiber.

Delfos 324: Developed from Delfos 6102. Plant selected in 1923 but strain never introduced commercially. Seed stocks lost in the flood of 1927. Larger bolls, longer fiber than parent.

Delfos 531: Developed 1925–29. Selection of Delfos 6102. Higher lint percentage, longer fiber, greater productivity.

Delfos 719: Developed 1927–32. Progeny line of Delfos 324, substituted for it after the latter was lost. Bolls larger, rounder than parent, lint percentage higher, fiber shorter but of better quality.

Delfos 531A: Developed 1928–32. Selection of Delfos 531. Higher lint percentage, longer fiber, greater productivity.

Delfos 89 (developed 1928–33), *Delfos 9252* (developed 1929–34). Selections from Delfos 324 for larger boll, longer fiber, better picking quality.

Strains recently developed by private breeders in Arkansas:

Burdette Express (from Express 350), *Burdette Lone Star* (from Lone Star 65), *Burdette Trice* (from Mississippi Station Trice), *Burdette Acala* (from Acala 8), *Burdette Delfos* (from Delfos 6102): Developed by the Burdette Plantation, Burdette, Ark.

Roldo Rowden 40–2–9: Developed from Arkansas Rowden 40 by Robert L. Dortch, Scott, Ark., in cooperation with Arkansas Agricultural Experiment Station. Roldo Rowden 40–9–F–6–3–1 more recently developed by Dortch.

Acala 37–6: Developed from Acala 37A by the Loy E. Rast Cotton Seed Co., Newport, Ark.

Wilson Type Big Boll: Developed by Lee Wilson & Co., Wilson, Ark., from a strain of Piedmont Cleveland provided by H. W. M. Collins, plant breeder for the company.

Strains recently developed by private breeders in Texas:

Gorham Lone Star: 1906, Developed by John Gorham & Son, Waco, Tex., from Lone Star. Work was carried on continuously for 30 years, beginning with the original selection, which was grown on this farm the year after it was made by D. A. Saunders in 1905. Staple 31/32 to 1 1/32 inches, gin outturn 38 to 41 percent, bolls about 60 to the pound.

New Boykin and Ferguson Triumph 406: 1908, Developed by the Ferguson Seed Farms (formerly of Sherman, now of Howe, Tex.), from Mebane Triumph. Both early, small, low-branching plants; staple 7/8 to 1 inch, gin outturn 36 to 39 percent, bolls medium to large, storm-resistant. Widely distributed in northern Texas, Oklahoma, and Arkansas for a number of years. Somewhat more concentrated in Texas in recent years.

Buckelew Mebane: Introduced about 1912 by Buckelew Bros., Troy, Tex. Strain of Mebane Triumph.

Kasch: Introduced about 1912 by Ed Kasch, San Marcos, Tex. Strain of Mebane Triumph. Widely sold for a number of years.

Bennett Lone Star: Introduced about 1917 by R. L. Bennett & Sons, then located at Paris, Tex., now at San Antonio. (R. L. Bennett had formerly been with the United States Department of Agriculture and cooperated with the Texas Agricultural Experiment Station in cotton-breeding work.) Somewhat more uniform and slightly shorter jointed than the parental strain, but too late maturing to maintain popularity in the regions where the seed was usually

sold. About 1926, Bennett began to breed an earlier type of Lone Star; later he developed from new stocks a strain somewhat like Stoneville. Present stocks of the firm are reported to be represented by two strains, designated as Row 5 and Row 8.

Lankart: 1918. Variety developed from Lone Star by C. S. Lankart, Waco, Tex. First selection in 1911, thought to have been a natural hybrid. Spreading plant, drought-resistant; bolls very large, storm-resistant; gin outturn 38 to 41 percent; staple 31/32 to 1 1/32 inches.

Bryant Mebane: About 1918. Strain of Mebane Triumph introduced by John J. Bryant, Corsicana, Tex. Compact plant, early bolls, large, picks well; gin outturn 38 to 41 percent, staple 15/16 to 1 inch and hard-bodied.

Sunshine: About 1918. Strain of Rowden, introduced by the J. W. Davidson Co., McKinney, Tex. Earlier than parent, staple 15/16 to 1 1/32 inches, gin outturn 34 to 37 percent, bolls 65 to 70 to the pound.

H–X: Introduced about 1920, by Kinsler-Hartman, Austwell, Tex. The parent of H–X was a strain of Lone Star introduced by this firm in 1916. Both have a gin outturn of 38 to 41 percent, bolls around 60 to the pound. H–X has a much shorter jointed plant than the Lone Star strain.

Russell (not to be confused with the Russell having green seeds developed in Georgia from Truitt): Introduced about 1920. Strain of Lone Star, introduced by the Russell Cotton Breeding Farms, Annona, Tex. Somewhat earlier than parent. Staple 15/16 to 1 1/32 inches, gin outturn 36 to 38 percent, bolls about 70 to the pound.

Worley Boykin: About 1921. Strain of New Boykin, introduced by F. W. Worley, Rockdale, Tex.

Young Improved Acala: 1922. Acala 5 type, produced by W. T. Young, Acala, Tex. (died Apr. 8, 1935). Breeding work practiced and new strains of the type Y 23 and Number 9 introduced. W. Z. Ryan, breeder 1925 to 1935.

Harper: About 1922. Selection of Mebane Triumph, developed by Robert M. Harper, Martindale, Tex. Staple 15/16 to 1 inch, gin outturn 38 to 41 percent, bolls about 70 to the pound. Continuously bred for about 15 years.

Paris Big Boll: About 1922. Stock of Bennett Lone Star, introduced by Farmers' Seed & Gin Co., Paris, Tex. Staple 31/32 to 1 1/32 inches, gin outturn 38 to 41 percent, bolls around 60 to the pound.

Qualla: About 1922. Strain of Mebane Triumph, developed by H. Conrads, San Marcos, Tex. Staple 15/16 to 1 inch, gin outturn 38 to 41 percent, bolls 70 to the pound. Widely distributed in Texas and adjoining States. Most popular recent variety in Texas outside of Kasch.

Hurley Special: 1923. Strain of Rowden, introduced by H. C. Hurley, Cooper, Tex. Breeding work begun in 1912. Somewhat earlier than parent, better gin outturn, more uniform staple, better quality of fiber.

Rogers Improved Acala: Introduced commercially about 1923 by John D. Rogers, Navasota, Tex. Breeding begun in 1921. Rogers strains have been multiplied and distributed by the Sartartia Plantation and the Sugarland Industries, Sugarland, Tex. Recently R. H. Goble & Co., ginners, Sherman, Tex., through their customers, have been growing Rogers Improved Acala and marketing the seed as State certified.

Cliett Superior: Introduced 1924 by the Cliett Cotton Breeding Farms, San Marcos, Tex. Developed from Mebane Triumph stocks obtained from A. D. Mebane in 1920, when the breeding work was begun. Better strains brought out subsequently under this trade name. Bred more especially for central and western Texas and western Oklahoma.

Hasselfield Lone Star: 1924. Produced by O'Connor-Hasselfield, Tivoli, Tex. Strain of Lone Star. Selection work begun in 1921 by B. V. Hasselfield. Stock kept up to present time by continuous selection. Strong short-jointed main stem, long fruiting branches, large bolls hanging downward, high lint percentage, lint of high quality.

Texas Special: 1925. Strain of Kasch, introduced by Stufflebeme Bros., Itasca, Tex. Staple 31/32 to 1 1/32 inches, boll size and gin outturn similar to parent.

Chapman Ranch Mebane: 1926. Strain of Mebane Triumph, introduced by the Chapman Ranch, Chapman Ranch, Tex. Gin outturn 38 to 41 percent, bolls about 70 to the pound, staple 15/16 to 1 inch.

Wacona: 1927. Variety developed from Lankart. First plant selected in 1921. Plant short, compact, and rigid. Somewhat earlier than Lankart. Bolls somewhat smaller (about 60 to the pound), round nose, storm-resistant, gin outturn 33 to 35 percent, lint 1 1/32 to 1 1/16 plus.

Aldridge A–1: Introduced about 1927 by the Aldridge Seed Farms, Plano, Tex. Strain of Kasch.

Texas Mammoth: Introduced about 1927 by the Von Roeder Seed Farms, Knapp, Tex. Strain of Mebane Triumph. Breeding work begun in 1923.

More vigorous and more open plant, bolls larger and bur heavier, staple longer than parental variety.

Saunders Special: Introduced about 1929 by the Saunders Seed Co., Greenville, Tex. Strain of Kasch.

Bagley Better Cotton: Introduced 1930 by W. W. Bagley & Sons, Martindale, Tex. Strain of Mebane Triumph. Breeding work began 1919. Large bolls, superior staple, productiveness are some of the objectives of the breeder.

Watson: Present strain introduced about 1932 by Ferris Watson, Garland, Tex. Developed from older lines of Mebane Triumph. Began breeding work in 1907 with stocks of seed from A. D. Mebane. Watson formerly bred and sold a strain of Acala 8 also.

Summary of Research in Cotton Breeding and Genetics at State Stations

Inheritance of Qualitative Characters

ARIZONA.—Determined: Red plant color, single factor difference from normal green. Yellow pollen color, single factor difference from normal cream. Slick seed, single factor difference from normal fuzz.

ARKANSAS.—Determined: Plant color and okra-leaf shape each single factor differences from normal. Three kinds of brown lint: Nankeen, Algerian brown, and Texas rust, each single factor differences from normal. Green lint, single factor difference from normal. Each of these characters is of the intermediate type of inheritance. Being studied: Petal spot, anther color, gland color. Linkages: Plant color, okra-leaf shape, and lint color (Nankeen or green) are inherited independently. No definite linkage studies being made. All characters so far are apparently independent.

FLORIDA (cotton work discontinued in 1933).—Determined: Monohybrids, dominant listed first: Naked seed versus fuzzy tip seed, fuzzy tip seed versus fuzzy seed, petal spot versus no petal spot, buff anther versus white anther, colored seed fuzz versus colorless fuzz. Incompletely dominant monohybrids: Okra leaf versus normal, red plant color versus green plant color.

LOUISIANA.—Being studied: Leaf shape, leaf form (round leaf), plant hairiness.

MISSISSIPPI.—Determined: Such characters as plant color, leaf shape, lint color, and seed coat which have been worked out before by other workers have been verified. Being studied: Attempting to determine whether any of the above characters are associated in any way with lint length.

NEW MEXICO.—Determined: Another color, yellow versus white. Two factors *P* and *B* responsible for color. Inhibitor *I* prevents action of *P* or *B* where one is present without the other.

NORTH CAROLINA.—Determined: Smooth (black) seed × fuzzy seed 3 : 1 ratio. Smooth seed × fuzzy tip seed 12 : 3 : 1 ratio. Fuzzy tip seed × fuzzy seed 3 : 1 ratio.

OKLAHOMA.—Determined: Plant color, red and yellow each by normal. Leaf shape, okra, and Egyptian each by normal. Lint, brown by normal. All 3 : 1 ratios, but not all cases definitely proved. Being studied: Further work on same characters.

TENNESSEE.—Being studied: Green, brown, and gray fuzz.

TEXAS.—Determined: Pollen color—3 dark yellow, 1 light yellow; 3 light yellow, 1 cream. Petal color—3 yellow, 1 cream. Petal spot—3 spot, 1 no spot. Lint color—3 brown, 1 white; 3 green, 1 white. Leaf shape—1 normal, 2 intermediate, 1 forked. Seed fuzziness—3 naked, 1 fuzzy (*G. hirsutum*). Leaf color—3 red, 1 green; 3 green, 1 virescent yellow; 3 bronze, 1 virescent yellow; 3 green, 1 yellow (lethal); 15 green, 1 yellow (lethal). Being studied: Short fruiting branch, withered lock, branched stamens, leaf color, leaf shape, lintless, lint color, cotyledon folding, petal color, petal spot, pollen color, chimaeras, fluted edge leaf, storm resistance, sunken boll.

Inheritance of Quantitative Characters

ARIZONA.—Determined: Lint length and seed size, each controlled by a number of factors. Being studied: Length of branches and size of bolls. Inheritance of fineness of fiber in hybrids. Correlations: Slick seed and low lint percentage. Fuzzy seed and high lint percentage. Extreme earliness and low yields. Long lint and low lint percentage. Extreme earliness and small bolls.

ARKANSAS.—Determined: Height of plant, number of nodes, length of staple, lint index, seed weight, lint percentage. Each of these characters apparently influenced by a number of factors. Sparse lint and abundant lint segregate

bimodally. Being studied: Oil and protein content and other seed and plant characters. Degrees of seed fuzziness, lint percentage. Fiber length, diameter, strength, uniformity, and color as measured by more refined methods. Correlations: Softness or silkiness of lint and green color. Sparse lint and clean or slick seeds.

LOUISIANA.—Correlations: Boll size and seed size.

MISSISSIPPI.—Being studied: Lint percentage and staple length. Correlations: The bare seed coat and green lint factors depress the expression of lint percentage.

NEW MEXICO.—Determined: None except in connection with correlation studies. Correlations: Lint index and lint percentage positive in four lines tested. Boll weight and lint index positive in two lines tested. Boll weight and total bolls positive in one line tested. Boll weight and loss in length positive in one line tested. Boll weight and total fibers positive in one line tested.

NORTH CAROLINA.—Determined: High lint percentage dominant to low percentage, several factor difference. Correlations: High degree between smooth seed and low lint percentage.

OKLAHOMA.—Determined: Sparse lint by normal lint, 25 percent sparse linted in F_2. Being studied: Lint percentage, lint length, amount of fuzz, cluster type of plant. Correlations: Possibly exists between color of lint and amount of fuzz and between lint percentage and amount of fuzz. Other correlations, see Oklahoma Experiment Station Bulletin 187.

TENNESSEE.—Being studied: Length and fineness of fiber. Cluster types and their relation to quality of lint. Correlations: Fiber length and fineness in relation to the fuzz colors are being studied.

TEXAS.—Determined: Length of lint—multiple factors; percentage of lint—multiple factors; shape of boll—varietal crosses, single factor; species crosses, multiple factors. Loculi number—varietal crosses, single factor; species crosses, multiple factors. Petal length—multiple factors. Stigma length—multiple factors. Being studied: Short petal, effect of leaf color on yield, length of lint, percentage of lint, shape of boll, stigma length, petal length, number of loculi. Correlations: Seed fuzziness and amount of lint, plant color and fruiting habit, petal color and number of loculi, pollen color and number of loculi, petal color and pollen color, lignin and palisade cells. Length and percentage of lint in F_2 of varietal and species crosses showed low negative correlation. Also see Texas Agricultural Experiment Station Bulletins 332, 354, 364, 369, and 452 for additional results.

Fiber Research

ARIZONA.—Study of effects of selection on uniformity of lint length indicates possibility of establishing strains with less substaple than exists in those ordinarily grown.

ARKANSAS.—Studies on the influence of environmental factors on 16 fiber and seed variables completed. Variety, location, and season identified as highly significant contributors to variation. Individualistic response of varieties and variables to environmental conditions was found. Metaxenia in fiber diameter has been established in certain crosses.

LOUISIANA.—Length and uniformity studies of prominent varieties of the State. (See Louisiana Experiment Station Bulletin 259.)

NEW MEXICO.—Fiber sorter used especially for determining percentage of 1⅛ inches plus fibers. Uniformity of length being stressed in present researches.

NORTH CAROLINA.—Studies of source and care of planting seed under farm conditions in relation to length of staple show that improved stocks are a very important factor in the production of uniform staple length. The value of pure seed stocks has been demonstrated in spinning tests. Fiber fineness has been isolated and this property is being evaluated in manufacturing tests. Results so far are very encouraging.

OKLAHOMA.—Length, strength, and uniformity studies as affected by disease, fertilizer, variety, time of picking, and self-pollination.

TENNESSEE.—Fiber graph studies are being made on position of hairs around seed, on different seeds in lock, on different locks in boll, and on different bolls. Five thousand six hundred bolls were cataloged for this study.

TEXAS.—Studies have been initiated to determine the inheritance of strength, length, diameter, and convolutions.

Methods for Inducing Mutations and Results

ARKANSAS.—One hundred seeds from each of the 8 pure genotypes of the trihybrid red plant, okra leaf, lint color combination were subjected to X-ray treatment, using a dosage of 12 milliamperes, 50 kilovolts, 18-cm target distance, and 30- and

60-minute exposures. No mutations were found in the plants developed from the treated seeds nor in the next generation.

CALIFORNIA (all Federal work).—X-rays used to limited extent; results so far very unsatisfactory.

LOUISIANA.—X-ray treatment given dry seed, soaked seed, and flower buds. Several stunted and abnormal forms were secured but nothing of economic value.

TENNESSEE.—Trying place effect. California Acala has been grown on a 5-acre area successfully for the past 6 years at Murfreesboro. The seed have been saved and planted the following year. No mutations have been observed as yet.

TEXAS.—Dry seed exposed to X-ray at dosages of 15, 30, 45, 60 minutes, 100 kilovolts, 5 milliamperes, and 17-cm target distance. Produced mutations, including progressive mutations in leaf color and shape which are transmitted to succeeding generations. Artificial induction of polyploidy by low and high temperatures is also being tried.

Cotton Degeneration Studies

MISSISSIPPI.—Cotton degeneration studies to determine in what ways and how rapidly varieties deteriorate and to determine what plant breeding methods would best maintain a strain or variety of cotton once it is bred to a high state of purity.

Plant Characters Emphasized as Objectives of Improvement in the Breeding Programs at State Stations

[Listed in each case in the order given by the workers reporting]

ALABAMA.—Early maturity, high yield, medium to large bolls, 1 5/16 to 1 1/16 inches staple, ease of picking, high gin outturn, disease resistance.

ARIZONA.—Upland—High yield, uniformity of lint length and plant type, high lint percentage, high lint index, large bolls, storm resistance, disease resistance, earliness.

ARIZONA (Federal work on American-Egyptian).—A productive, early-maturing, as nearly as possible limbless plant, with lint of relatively uniform length, fine, strong and abundant, and seeds as nearly smooth as possible.

ARKANSAS.—Early maturity, high yield, medium to large bolls, medium staple length for upland, longer staple for bottom land, generally good fiber quality, high lint percentage, wilt tolerance or resistance, storm resistance.

CALIFORNIA (all Federal work).—Strong upright stalk, indeterminate habit of growth, open type as distinguished from cluster, disease resistance.

GEORGIA.—High yield, a good quality of lint, wilt resistance.

LOUISIANA.—Better production, more uniform staple, larger bolls, longer staple in Dixie-Triumph selections.

MISSISSIPPI.—For upland, somewhat more vigorous and spreading plants, medium foliage, medium to big bolls. For Delta, light foliage, smaller plants, 1⅛-inch to 1 3/16-inch staple. High yields in both sections.

NEW MEXICO.—Uniformity of staple length, seedling vigor.

NORTH CAROLINA.—Medium growth, light foliage, early maturity, large bolls, 1 1/16-inch staple, high spinning quality.

OKLAHOMA.—Earliness, large bolls, high lint percentage, inch lint length, uniformity, and high quality of fiber.

SOUTH CAROLINA (breeding work commercial entirely).—Yield, high lint percentage, satisfactory length of lint, strength and uniformity of lint, earliness of fruiting and maturity, size of boll, thickness and toughness of hull, disease resistance, storm resistance, ease of picking.

TENNESSEE.—Staple 1 to 1 1/16 inches, earliness, 35 to 45 percent of crop harvested first picking, yield comparable with Stoneville 2, size of boll not more than 80 to the pound, lint index around 7.5, lint percentage not below 35 percent, vigorous prolific spreading type of plant.

TEXAS.—High yield of tenderable staple, high lint percentage, large storm-resistant bolls, types adapted to mechanical harvesting.

Department of Agriculture

The Department of Agriculture through the Division of Cotton and Other Fiber Crops and Diseases of the Bureau of Plant Industry is cooperating in cotton breeding or genetics with all the State stations in the Cotton Belt that have a research program of this kind. Last year Department personnel were placed in North Carolina, South Carolina, Georgia, Tennessee, and Mississippi. In 1936 field men have been located at Alabama, Louisiana, Arkansas, Oklahoma, and Texas. For some years the Department has had field stations in Texas, New Mexico Arizona, and California. The Department has been carrying on

cytogenetic and toxonomic studies of cotton and some of its relatives in California and genetic studies in Egyptian and upland cotton in Arizona. In 1935 genetic studies in upland cotton were begun cooperatively in South Carolina and Mississippi. In 1936 cooperative work in genetic studies was begun with Arkansas and Texas. Breeding and improvement work has been carried on for a number of years at various points in the Cotton Belt. Cooperative breeding and improvement work was begun in 1935 with the stations of North Carolina, South Carolina, Georgia, and Tennessee, and in 1936 this cooperative arrangement in cotton breeding and improvement was extended to Oklahoma, Louisiana, and Alabama.

List of State Station and Federal Field Workers in Cotton Breeding and Genetics in the United States

[Asterisks denote: (*) Federal; (**) State and Federal]

State	Post office	Name of worker
Alabama	Auburn	H. B. Tisdale** (cotton breeding).
	do	J. B. Dick* (cotton breeding).
Arizona	Tucson	W. E. Bryan (cotton breeding).
	do	E. H. Pressley (cotton breeding).
	Sacaton	C. J. King* (cotton breeding).
	do	R. H. Peebles* (Egyptian cotton breeding and genetics).
	do	H. J. Fulton* (Egyptian cotton breeding and genetics).
Arkansas	Fayetteville	L. M. Humphrey (cotton breeding and genetics).
	do	Landis S. Bennett* (cotton genetics and breeding).
California	Riverside	J. M. Webber* (cotton genetics and cytology).
	Shafter	G. J. Harrison* (cotton breeding and genetics).
Georgia	Experiment	R. P. Bledsoe (cotton breeding).
	do	G. A. Hale (cotton breeding).
	do	W. W. Ballard* (cotton breeding).
	do	A. L. Smith* (cotton breeding in disease resistance).
Louisiana	Baton Rouge	H. B. Brown (cotton breeding and genetics).
	do	John R. Cotton* (cotton breeding and genetics).
Mississippi	State College	J. Fred O'Kelly (cotton breeding and genetics).
	Delta Branch Station, Stoneville.	W. E. Ayres (cotton breeding).
	do	H. A. York (cotton breeding).
	do	J. W. Neely* (cotton genetics and breeding).
New Mexico	State College	G. N. Stroman (cotton breeding and genetics).
	do	A. R. Leding* (cotton breeding).
North Carolina	Raleigh	J. H. Moore (cotton breeding in reference to fiber).
	do	P. H. Kime** (cotton breeding).
Oklahoma	Stillwater	L. L. Ligon* (cotton breeding and genetics).
South Carolina	Pee Dee Branch Station, Florence.	W. H. Jenkins* (cotton breeding and genetics).
Tennessee	Knoxville	Newman I. Hancock (cotton breeding).
	do	D. M. Simpson* (cotton breeding).
Texas	College Station	D. T. Killough (cotton breeding and genetics).
	do	G. T. McNess (cotton breeding).
	Substation No. 3, Angleton	R. H. Stansel (cotton breeding).
	Substation No. 1, Beeville	R. A. Hall (cotton breeding).
	Substation No. 12, Chillicothe.	J. R. Quinby (cotton breeding).
	Substation No. 6, Denton	P. B. Dunkle (cotton breeding).
	Substation No. 8, Lubbock	D. L. Jones (cotton breeding).
	Substation No. 11, Nacogdoches.	H. F. Morris (cotton breeding).
	College Station	T. R. Richmond* (cotton genetics and breeding).
	U. S. Field Station, Greenville.	H. C. McNamara* (cotton breeding).
	do	D. R. Hooton* (cotton breeding).